THIRTY-FOURTH ANNUAL REPORT

of the

North Carolina
Agricultural Experiment Station

of the

COLLEGE OF AGRICULTURE AND MECHANIC ARTS

for the

YEAR ENDING JUNE 30, 1911

Including

Scientific Papers and Bulletins 209, 210, 211, 212, 213, 214, 215, 216

WEST RALEIGH, NORTH CAROLINA

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N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

UNDER THE CONTROL OF THE

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A. F. BOWEN.....Bursar
LOULA V. SHERWOOD.....Secretary and Stenographer

The Bulletins and Reports of this Station will be mailed free to any resident of the State upon request.

Visitors are at all times cordially invited to inspect the work of the Station, the office of which is in the new Agricultural Building of the College.

Address all communications to

N. C. AGRICULTURAL EXPERIMENT STATION,
WEST RALEIGH, N. C.

North Carolina Agricultural Experiment Station,
Office of the Director.

West Raleigh, N. C., June 30, 1911.

To His Excellency, William W. Kitchin,
Governor of North Carolina.

Sir:—I have the honor to submit herewith the report of the operations of the North Carolina Agricultural Experiment Station of the North Carolina College of Agriculture and Mechanic Arts for the year ending June 30, 1911.

Trusting that this report will prove satisfactory to your Excellency, I am, Yours very truly,

C. B. Williams,
Director.

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THIRTY-FOURTH ANNUAL REPORT

of the Director of the

N. C. AGRICULTURAL EXPERIMENT STATION

for the Year Ending June 30, 1911

By the Director.

During the year marked improvement has taken place in the development of the work of the Station. Many new lines of investigation have been inaugurated and some old ones have either been completed or work on them enlarged by further study. The character and value of the work that is being carried on by the Station may be gathered from the *résumé* of the several divisions given below. This is made up from the reports of the different workers and from the personal observations of the Director.

DIVISION OF AGRONOMY.

The workers of this Division have devoted most of their time during the year to a continuation of the corn suckers and soil fertility investigations. Much data has been secured on both of these projects, which will be put in shape for publication shortly. While in 1910 in the corn suckers investigations something like sixty different varieties of corn were used, in 1911 the work will be confined to a study of ten varieties selected with reference to their different types and their yielding powers. By this means a larger acreage can be devoted to each variety and more space given over to the suckers tests under different degrees of fertility of the soil and to the various spacing of plants in the rows. As a result of tests for three years it has been demonstrated that the production of suckers, although to a certain extent a varietal characteristic, is governed largely by the supply of available fertility of the soil. Other things being equal, the richer the soil the larger and more complete the development of these with all varieties. On good land the removal of suckers at the ordinary time tended generally during the past three years to a smaller yield of grain and stover than from those plats of the same varieties where they were allowed to remain and develop to maturity. On the more fertile plats the suckers have, in many instances, equalled that of the main stalks in size and in production of grain and stover. The Soil Fertility investigations are being conducted with corn and cotton along the same general lines as reported last year. In all, 88 plats are in use in these investigations. To supplement this work miscellaneous fertilizer experiments are also being carried on in more detail with corn and cotton to determine the relative value of different carriers of phosphoric acid and nitrogen for these crops when planted on a clay loam soil under ordinary conditions. There are used in these experiments, with cotton, twelve plats for different nitrogenous fertilizing

materials, fourteen for basic slag, and nine each for finely ground phosphate rock and Peruvian guano; and with corn thirteen plats for nitrogen carriers, sixteen for basic slag, and nine for finely ground phosphate rock. On the main fertilizer plats observations are being made to determine the effect of applications of stable manure on all the plats at stated intervals upon the actual and relative productivity of the corn and cotton, and also upon the bacterial flora of the plats, especially on the ones which have heretofore produced the minimum and maximum yields. In the study of different varieties of different crops the tests have embraced fifty-nine of corn, thirty-nine of cotton, fourteen of wheat, twenty-three of oats, twenty-six of cowpeas, twenty-one of soy-beans, eleven of adsuki beans, and two of seta beans. In the corn tests Sanders' Improved, Biggs' Seven-ear, and Hastings' Prolific have stood best on an average in yield of grain; Toole's Prolific, Hope's Mexican Big Boll, Culpepper's Re-improved, Pulnot, and Wilbur Varieties of cotton were the leaders. As it has been clearly demonstrated by our tests of corn that the relative standing of the different varieties is greatly modified both by fertility of the soil and the distance given the individual plants of the several varieties, similar experiments have been started with three varieties of cotton to determine the effect of these factors upon the relative yields of this crop. Results thus far secured with corn have indicated strongly that variety tests as ordinarily carried on and the results reported do not generally have very great value to the average farmer. In the tests of varieties of wheat, Purple Straw, Harvest King, Golden Chaff, and Red May, all beardless varieties, have shown up as best yielders; while with fall sown oats, Virginia Gray and Appler have shown as some of the best in total yield of grain and hay per acre. Other oats doing fairly well are the Bancroft, Big Four, Ohio Winter, Red Rust Proof, and Czar of Russia. The Burt, a spring oat, has many good characteristics in its favor, they being fineness of straw and leaves and ease of curing. The best yielding varieties of cowpeas have been Whippoorwill, Small Black, Small Black Eye, Groit, and Iron in shelled peas; and Whippoorwill, Southdown, Black, Brabham, Iron, Clay, and Unknown in hay; and of soy beans, Mammoth Yellow, Hollybrook, Haberlandt, and Jet in seed, and Morse, Jet, Haberlandt, and Mammoth Yellow in hay. Of the varieties tested the earliest ones in date of maturity have been White's Early Prolific, New Era, Early Unknown, Small Black, Small Black Eye, and Large Black Eye with cowpeas; and Jet, Guelph, Amherst, Kingston, Ebony, and Haberlandt with soy beans. All the early varieties of soy beans except Ebony are unsuited for picking, as they ripen unevenly and shatter badly upon becoming ripe.

With adsuki beans promising results were secured during the past fall, in fact the yields of seed per acre were better from these than from cowpeas. They require ordinarily a longer time for maturity than cowpeas, but a less number of days than soy beans, it requiring last year less than one hundred days from planting to maturity. The results with two varieties of seta beans have been very promising as the plants have grown luxuriantly and fruited fairly well.

During the past two years coöperative variety experiments with corn and cotton have been conducted by the Station with a good many farm-

ers in different portions of the State. Very striking results were secured last year in the different sections as showing the adaptability of different varieties for different soils. Sanders' Improved, Biggs' Seven-ear and Weekley's Improved varieties of corn and Cook's Improved, Toole's Prolific, Peterkin's Improved, King's Improved, Culpepper's Improved, and Excelsior Prolific varieties of cotton proved the best yielders in the hands of the farmers conducting the tests. Up to the time this work was undertaken very little field work out in the State had been done in a systematic way to call the attention of our farmers to varietal adaptations of different crops to different soils and sections of North Carolina. Feeling that this work, when carefully carried out, would be of great benefit to the farmers, considerable time has been spent in planning and getting it started in the best manner possible under the conditions. The Coöperative Tillage Experiments with the Office of Farm Management, Bureau of Plant Industry, started last year, are being continued this, all being planted in corn this year again to secure basic yields during two years for each plat before attempting a study of the effects upon the yields of different crops of various methods of preparation and cultivation of the soil. Two hundred and sixteen plats have been laid off and plotted for this particular phase of work. The experiments planned to determine the value of grain taken from different portions of the ear for seed purposes have shown that plants produced from grains from the middle of ears have yielded the highest amount of shelled corn per acre.

The breeding experiments with cotton and wheat mentioned in the last report have been continued during the year. The work has now progressed to that point at which the progeny from some of the crosses is of sufficient amount to plant a sufficient acreage in the experimental grounds given over to the variety tests to compare the relative value of the new strains as yielders in comparison with established and well known varieties of these crops being tested.

In the general farming operations of the Station cotton, corn, oats, wheat, rye, cowpeas, clovers, vetch, soy and velvet beans are being grown and during the year a systematic crop rotation has been arranged for the whole farm, in which most of these enter, the legumes and small cereals as cover crops at as frequent intervals as practicable. The rotations are so planned that they will afford field data of considerable practical value.

Outside of the purely experimental work this Division will this year have under its charge 18 acres in cotton, 34 in corn, 32 in oats, about 50 in cowpeas, and a few in soy and velvet beans. The crop production from the farm was larger with most of the crops during the fall of 1910 than it has been during any year of the encumbency of the present Director. Much new equipment in the way of mules, a horse, wagons, single and double disk harrows, riding cultivators, two-row planters, grain drills, gang and other plows, has been added.

DIVISION OF CHEMISTRY.

During the year most of the time of workers of this Division has been devoted to aiding in extending and carrying on work in connection with the Soil Bacteriology and the cottonseed meal toxicity investigations.

For the latter investigations 21 different kinds of feed have been prepared for feeding experimentally to 193 rabbits. The analytical work in connection with these experiments has required the making of 113 determination on samples of cottonseed meal and 4 of urine. Guinea pigs and hogs have been fed Sea Island cotton seed and meal, and hogs and rabbits varying amounts of sodium pyrophosphate. Both the seed and pyrophosphate have been found to be toxic to rabbits when fed as much as a grain per day, but with eighty-pound hogs receiving a quantity equivalent to the total phosphoric acid in a pound of cottonseed meal per day mixed with three pounds of red-dog flour they have made substantial gains since November 14, when they were started on the feed, up to the present (May 24), without showing any ill effect from the pyrophosphate. Residues from treatment with various extractive agents on upland cottonseed meal when fed have all been found to kill guinea pigs, although they contained inappreciable quantities of pyrophosphate. It is expected to close up much of this work during the summer, possibly before the end of the fiscal year.

This Division has coöperated with the Bacteriological Division in activity carrying forward the studies in soil bacteriology. In connection with the Bacteriological Soil Survey of the State, nitrification and denitrification studies, 2,687 determinations on 1,014 samples were made during the present year. Results of far-reaching value are being secured from these investigations.

Because of the seeming unreliability of two of the chemical methods used commonly for estimating quantitatively different forms of nitrogen, some attention has been devoted by the Division to a laboratory study and improvement of the Tiemann-Schulze method for determining nitrogen and the phenol-disulphonic acid method for nitrates.

Other chemical work has been done by this Division during the year on experimental fertilizing samples for the Agronomic Division, on reference samples for the A. O. A. C., and on a few miscellaneous samples for farmers. Several scientific papers embodying some of the results of the work of the Division have been prepared and published since the last report.

During the early part of the summer the Division will move into new and commodious quarters on the third floor of the new Engineering Building.

DIVISION OF PLANT PATHOLOGY AND BACTERIOLOGY.

The energies of this Division have been exerted mainly along the same general lines as previously reported. During the year, the experiments with tobacco to secure wilt resistant strains have been greatly enlarged by entering into coöperative relations with the National Bureau of Plant Industry. New work has been started in a badly wilt-infected field near Creedmoor, and also with some of the same soil placed in cylinders settled in the ground at the Station farm and at Creedmoor. In all 93 cylinders (2 feet by 2½ feet) are in use, 73 at West Raleigh and 20 at Creedmoor. The experiments embrace a study of different treatments of soils to determine the effect of each upon the development of the parasite responsible for this disease. Soil disinfectants, acid

and neutral chemicals, different rotative systems and bacterial cultures are being used in the investigations. A study of the value and wilt resistance of selections from the strains of previous years has been continued. The work on lettuce sclerotiniose has been carried on with quite satisfactory results. The Station lettuce beds in which 45 per cent of the plants were rendered unfit for market purposes in 1909 by the ravages of this disease have been rid of it through systematic treatment, based upon life history studies, to such an extent that in the springs of 1910 and 1911 less than one-half of one per cent of the plants in the beds became affected. The method is so simple and inexpensive relatively, that it would seem to be of the highest practical value. The results of these experiments have been brought together in bulletin form for publication.

The breeding experiments with watermelons that have been conducted during the past two or three years at Auburn coöperatively with the Bureau of Plant Industry have been continued during the year. Greater resistance of plants and higher commercial and edible qualities of melons have been secured than heretofore. During the year the apple canker, okra wilt, and a buckwheat disease have been studied particularly. All these diseases are of a serious nature and any information secured with reference to their life-history development will be found useful in working out means of eradication or control. A larger portion of the time of this Division, however, has been devoted to a continuation of the studies on nitrification. In a bacteriological soil survey of the State much data has been secured on the nitrifying and ammonifying powers of North Carolina soils and the relation these sustain to soil fertility.

Small control plats with different crops are being used to study the relative value of nitrate and ammoniacal nitrogen. Experiments are also in progress to determine the effects of the presence of various species of bacteria on the activity of nitrifying bacteria.

The studies on denitrification in the soil have been enlarged and continued during the year, especially those with reference to the danger of loss of nitrates in the presence of large quantities of organic matter in the soil. Some of the plats used by the Division of Agronomy in its soil fertility work are being studied bacteriologically by this Division; especially with the ones producing the highest and the smallest yields of cotton and corn per acre.

DIVISION OF POULTRY HUSBANDRY.

The main work of this Division has consisted chiefly in conducting various feeding experiments, carried on in duplicate under different yarding conditions, and incubation work in connection with these. Of this work, most of it has been embraced in two series of four pens each. The corresponding pens in the two series having been fed the same feed or a mixture of feeds, hence the differences shown between the series, each taken as a whole, would be due to yarding conditions. Fowls in Series I were enclosed in yards set in Bermuda grass and were less than one-fifth the size of those used in Series II, which were seeded in oats during the early fall, about two months before the experiment began.

The feeds used in the corresponding lots were whole corn alone; whole wheat alone; equal parts of whole corn and wheat, with a mash made up equally by weight of corn meal, wheat bran, and cottonseed meal; and equal parts of whole corn and wheat, with a mash of equal weight of corn meal, wheat bran, and an equal part of a mixture equally of bone and meat meal. In each pen were ten females and one male bird. Monthly weighings have been made of all individuals and a record kept of the eggs laid and feed consumed by each lot in both series of experiments with the two series. The larger and cheaper egg production this winter and spring has been secured by those fowls running on growing oats, while with the feeds, the mixture containing the meat and bone meal has been shown to be most economical in both series. The eggs from each of the pens in both series have been incubated separately and records kept of the hatchability and viability of chicks from each lot. It is proposed to put a portion of the progeny from hens in the different lots back under the respective yarding conditions and feeds next winter and spring, in order to determine the effects of these upon the progeny from year to year.

During the summer it is proposed to continue the feeding experiments with skimmilk in the same general way as conducted last summer. During the year there has been considerable demand upon the time of the Poultryman in the way of correspondence on poultry matters and lecture work at Farmers' Institutes, Short Courses, Girls' Poultry Clubs, and other meetings.

A bulletin on the "Feeding and Management of Poultry for Egg Production" has been prepared by the head of this Division and published during the year.

In all the work of the Division an effort has been made to study and emphasize the useful market qualities of birds and minimize the mere show qualities.

DIVISION OF HORTICULTURE.

The efforts of this Division have been confined largely during the year to work in connection with the investigations on double flower and self-sterility of blackberries, dewberries, and muscadine grapes. In the double flower studies the resistance of different varieties of blackberries and dewberries to this trouble has been determined. The effects of different methods of pruning, spraying with Bordeaux mixture is being studied in the field. An effort was made to determine the relation, if any, the premature dropping of the leaves by the presence of leaf spot and anthracnose as well as attack of aphids had on the development of this abnormal growth. In the laboratory work was conducted designed to work out the life history of any fungus that is present and might cause the double flower. These studies have led to the isolation and identification of the causal fungus as one of the Fusariums. Certain phases of this work will be continued during the year.

The self-sterility investigations with blackberries and dewberries have developed along the same general lines as previously reported, and the results of work of the year have, in a general way, confirmed those of previous years. Considerable time has been devoted to a determination

by field and laboratory methods of the self-sterility and self-fertility varieties of these as well as ascertaining whether self-sterile varieties produce pollen suitable for pollinating other self-sterile varieties. In all cases the pollen from self-sterile varieties has been found to be active and will pollinate the ovules of other self-sterile varieties. Of the fourteen varieties of dewberries and twenty-three varieties of blackberries under experiment, eight of the former and two of the latter have been shown to be self-sterile. Four or five of dewberries and twenty-one of blackberries are self-fertile.

During the year self-sterility studies have been carried on also with ten species of muscadine grapes, the major portion of the work having been with the Scuppernong, Mish, James, Thomas, and Flowers. Work thus far has indicated that all cultivated species of the muscadine group are unable to set fruit unless pollen from a male vine of the same species is provided at the proper time, as their pollen is sterile. One wild vine, however, has been found near the Station farm that appears to bear self-fertile flowers. A microscopic study of the pollen from many cultivated and wild vines has been made, to determine if any light can be shed on this important matter.

During the progress of this experiment many hybrids have been produced. These are being used in working out the laws that operate in the production of different species of the muscadine family with different colored fruit. Many hundred seedlings, as a result of last year's crosses, are under observation in the nursery row and greenhouse. Self-sterility and self-fertility studies have also been started with native and Japanese varieties of persimmon.

During the year a bulletin on the "Self-sterility of the Scuppernong and Other Muscadine Grapes" has been prepared by the Division and published.

DIVISION OF ANIMAL HUSBANDRY.

The time of this Division has been taken up largely with work in connection with the cottonseed meal toxicity investigations which are being conducted jointly with the Chemical, Animal Pathological, and Veterinary Divisions. Although most of the work is being carried on with rabbits and guinea pigs, twenty-four hogs have been fed experimentally during the year in furtherance of this investigation. A comparison has been made of the relative toxicity of Sea Island and ordinary upland cottonseed meal, with results indicating the former to be equally as harmful when fed to swine for prolonged periods as is the latter. Many extracts and residues of the meal have been fed to hogs, rabbits and guinea pigs under control. To hogs weighing 100 to 125 pounds the amount of meal fed has varied from 1 to 1½ pounds per day. On May 1 experiments were started with young pigs to see if immunity to the toxicity of cottonseed meal could be established by feeding the meal in very small quantities while the pigs are young and gradually increasing the feed as they grow older.

Feeding experiments with cottonseed meal to farm-work stock have been finished during the year and put in form for publication. The results of these experiments show that one pound of meal may generally

be substituted for 1½ pounds of corn in a ration for mules and horses, but that the meal should never be more than 12 to 15 per cent of the ration. In experiments, where such substitutions have been made, while the general health of the animals has been good and the working efficiency normal, there was no saving generally in the cost of the ration considering the prevailing prices of these feeds. During the past two winters car load lots of steers have been fed experimentally to determine the relative value of cottonseed hulls, corn-stover, silage and a mixture of the last two roughages with large quantities of cottonseed meal as the sole concentrate for finishing beef cattle. Considering the prevailing prices of these roughages in this section it was found as an average of two years results that the cheapest gains were made by the steers fed on corn silage as the roughage, and cottonseed hulls stood next. Those lots fed on corn silage alone and a mixture of silage and stover dressed out about 2 per cent higher each than those receiving cottonseed hulls as the roughage. The grazing experiments with hogs on a succession of green crops have been enlarged and continued during the year. Beginning in the early winter with fall-sown oats or rye, spring-sown oats and Canada field peas and rape alone or with early spring-sown oats for late spring, followed by cowpeas or soja beans, and later, peanuts or sweet potatoes, a succession of crops is provided for the hogs throughout the entire year.

The swine-grading experiments are being continued along the same general lines as previously reported. During the year several pure-bred Berkshire hogs and Shropshire sheep have been secured by purchase.

In addition to the bulletin mentioned above this Division has prepared another one on "Selection and Feeding of Beef Cattle." Some additions have been made to the equipment of the Division which will add materially to its working efficiency.

DIVISION OF DAIRY HUSBANDRY.

During the latter part of last year the Station lost its Dairy Husbandman through resignation. The present encumbent assumed his duties on September 1 last. He, after familiarizing himself with the previous work of the Station along dairy lines, planned and started some cottonseed meal feeding experiments with heifers and young calves to determine its effect upon their health and general development. Twelve heifers, ranging in age from 5 to 10 months, were selected for the work and divided into two lots of approximately equal age and size. These lots were fed mixtures of equal parts of corn meal, oats, and wheat bran, and equal parts of cottonseed meal, oats, and wheat bran, respectively. Both lots were fed the same roughage, consisting of a mixture of corn silage and hay. Heifers which were ten months of age have been able to handle the ration containing cottonseed meal to the extent of one pound per day, but those ranging from five to seven months old have either lost or made practically no gains. The lot fed on the corn-oat-bran ration are thrifty and have made rapid gains. Observations are being made to determine the actual cost of raising heifers on different feeds and combinations from birth to the time they come into milk. Skimmilk will constitute the basis of the ration for the first fourteen

weeks. Linseed meal, Schumacher calf meal and grain consisting of a mixture of equal parts of corn meal, oats and wheat bran will be combined with the milk in the different rations to determine their relative cheapness as feeds for young stock. Other feeding experiments with Bovita and other cottonseed meal and hull mixtures, using the dairy herd of the college, were started during the latter part of May. A bulletin by the Dairy Husbandman on the feeding and management of the dairy herd will be finished for publication about the middle of June. In all the experimental work of this Division the college dairy herd, consisting of about sixty animals, has been used.

DIVISION OF ENTOMOLOGY.

The Entomologist was concerned during the fall principally with a study of the habits and life history of two melon worms. The work was conducted chiefly at West Raleigh and in the cantaloupe growing sections of Robeson, Scotland, and Columbus counties. Results thus far secured show that ordinarily the early crop of cantaloupes is affected but little by these pests, and that late sowings may be grown without much injury, if summer squash is used properly as a trap plant. The results of the investigations indicate that cantaloupe growers must depend largely upon early crops, proper cultural methods, rotation of crops and the use of trap plants.

One of the species of melon worms studied does not seem to make its appearance in the fields in injurious numbers in North Carolina until after the maturity of the cantaloupe crop. This species is also rendered of slight economic importance by its parasitic enemies.

The corn bill bug has been reported in damaging numbers from many of the coastal plain counties during the year. Three species of this bug have been taken during the year, one of which has done practically all the damage to the crops.

During the fall some preliminary life history studies were carried on with this pest, and this work will employ the Entomologist chiefly during the spring, summer and fall of 1911. A study will be made of habits, food plants, hibernation, generations, and activities of this pest. Work of the Entomologist so far has shown that the bill bugs breed in young corn and in certain species of grass growing in lowlands.

Observations on bill bugs under control indicate that they hibernate in the soil. The Entomologist has made general notes and observations on other injurious insects occurring in the State. Many specimens have been collected and preserved. A bulletin on "Two Important Cantaloupe Pests" has been prepared during the year by this Division and published. In this bulletin are embodied many of the observations and results secured in the investigations that are being carried on with melon worms.

DIVISION OF VETERINARY SCIENCE.

As in previous years, the major part of the work of this Division has been expended in a furtherance of the investigations that are being conducted by the Station to determine the cause or causes for the fatal results usually following the feeding of cottonseed meal to swine beyond

a certain quantity and period. The Veterinarian, during the year, has aided in conducting autopsies on more than sixty animals. He has found that the characteristic antemortem symptoms of cottonseed meal poisoning has developed in hogs in from 6 to 20 weeks, the length of the time before their appearance being governed by many factors, such as age and individuality of animals and amount of meal fed per day as well as methods of feeding. In all cases with hogs after a time of feeding with cottonseed meal the feces become hard and compact.

On October 6 a calf and pig weighing 175 and 95 pounds respectively were started on a feed of cottonseed meal, each receiving 1 per cent of his body weight of meal per day. This was continued until February 10, when the feed of meal was increased to 1½ per cent of original body weight; and on April 20 the ration to the calf was increased to 2 per cent, but the pig has remained on a feed of 1½ per cent of weight as he has refused to eat a larger amount. Although the pig and calf have made fairly good gains (up to May 25), they do not present a thrifty appearance.

The ante-mortem observations and autopsic revelations have coincided with those of the previous year, in the cottonseed meal investigations. The Veterinarian has had, during the year, an increased number of enquiries with reference to the diagnosis and treatment of various animal diseases.

DIVISION OF ANIMAL PATHOLOGY.

This Division of the Station was created a year ago because of the urgency for more pathological work at the time in connection with the cottonseed meal feeding investigations with swine, rabbits and guinea pigs. On September 1 the new Pathologist entered upon his duties and during the year practically all his Station time has been taken up with work on the cottonseed meal project. The Animal Pathologist has been especially helpful in putting the experiments in better shape. The stock room and caging of the small animals used in the investigations have been greatly improved. The old quarters and system of caging were found unsatisfactory. New cages have been provided and a special room for the animals has been secured on the third floor of the new Engineering Building, near the new quarters provided for the Chemical Division of the College and Station.

The Pathologist is now making detailed daily observations on all animals used in the experiments. An effort is being made to determine the exact pathological changes that take place in the various organs and tissues of animals dying of cottonseed meal poisoning. Experiments have been started to determine if the small animals used in the investigations can be fed in such a way and manner as to become immune to the harmful effect of the meal feeding. It has been planned to make a chemical and microscopic study of the blood of all animals succumbing to the effects of the meal, and to ascertain if auto-intoxication is produced. Various feeds, extracts, residues, etc., have been fed during the year, both forced and naturally. Specimens are preserved from all autopsies for histological studies.

The Pathologist has devoted some extra time to fowl cholera studies, especially on vaccination against this disease. The results have been encouraging.

NEW BUILDING AND EQUIPMENT.

Commodious and well lighted quarters have been provided by the College for the Station laboratories, store-rooms and offices of the Chemical Division on the third floor of the new Engineering Building. This will be occupied as soon as the necessary plumbing and carpenter work is completed. New and better laboratory apparatus has been secured during the year by all the Divisions having laboratories. The farm equipment has been materially improved and increased through purchase.

BULLETINS.

Bulletins have been issued during the year as follows:

No. 209.—Self-sterility of the Scuppernong and Other Muscadine Grapes, by F. C. Reimer and L. R. Detjen.

No. 210.—Improved Methods for Making Cottage and Neufchatel Cheese, by John Michels.

No. 211.—Feeding and Management of Poultry for Egg Production, by J. S. Jeffrey.

No. 212.—Prevention of Oat and Wheat Smut, by F. L. Stevens.

No. 213.—Feeding Experiments with Cows and Calves, by John Michels.

No. 214.—Two Important Cantaloupe Pests, by R. I. Smith.

No. 215.—Cottonseed Meal Feeding Experiments with Mules and Horses, by R. S. Curtis.

No. 216.—Feeding Cottonseed Meal to Draft Animals, by R. S. Curtis.

No. 22 (Press Bulletin).—Use of Lime on the Farm, by C. B. Williams.

No. 23 (Press Bulletin).—How to Suppress Houseflies, by R. I. Smith.

REPORT OF DIVISION OF AGRONOMY.

The following statement reports the work of the Department of Agronomy for the year ending June 30, 1911, giving the general progress of the field experiments and their present condition.

VARIETY TESTING.

Corn.—The usual variety test of corn was continued this year and embraced 59 varieties in connection with which were carried on the experiment with suckers. From the part of the experiment concerned with suckers the results of 1910 are generally in line with those of 1908 and 1909. Field counts, measurements and weights of suckers sprouted under different conditions of soil fertility show conclusively that their production, maintenance and development depends mainly upon the amount of plant food with which the main stalk is supplied. On soil made very rich a rank growth of suckers sprouted and reached maturity, many of them equalling the main stalk in size and productiveness; while on the poor soil only a comparatively insignificant number made their appearance and among these there was rarely any development beyond the stage of being merely an appendage at the base of the main stalk.

The 1910 results as to the relation between the removal of suckers and lessening in total value the yield are partly in accord with those of former years. On rich land with the plants distanced 30 inches in the row there was a considerable loss caused by removing suckers, but on land of similar fertility with plants spaced 20 inches in the row there was a slight gain in combined value of grain and stover. Among the varieties Sanders' Improved, Biggs' Seven-ear, and Hasting's Prolific have a higher average rank for all conditions than any other variety.

Cotton.—The 1910 variety test of cotton carried 39 varieties. Wilbur No. 1 and Wilbur No. 2, tested for the first time, made a very good showing, taking first and second place in combined value of lint and seed. A few varieties have done well for more than one year. Toole's Prolific, Hope's Mexican Big Boll, Culpepper's Re-improved, Triumph, and Pulnot have maintained a high average rank through two and three years of testing. In addition to the comparison of varieties with respect to their actual monetary value, an intimate and detailed study is being made of their characteristics with the hope of discovering correlations between yield and superiority along more narrow lines.

Wheat.—The variety test of wheat has been carried though five years, 1906-1911, and from ten to fifteen varieties have been under experiment each year, but until 1910 the department did not possess the threshing equipment necessary to secure accurate and hence reliable results in yield of threshed grain. The threshing had been previously done by hand, a very crude process which was necessarily accompanied by considerable inaccuracy. With the purchase of a small threshing machine, however, for the experimental wheat and oat crops of 1910 this liability to error through the threshing process has been elminated, and for the past two years thoroughly reliable results have been secured in

yields of grain. Among the fourteen regular varieties tested last year the three best were Purple Straw, Currell's Prolific, and Red May. Purple Straw, notwithstanding the crude method of threshing to which the varieties have previously been subjected, has been rather consistently at the front, standing among the three best yielders of grain three years out of the four, and ranking well above the average in the other year. Harvest King, Golden Chaff, and Red May have also proven to be excellent varieties during the four years test. The test for 1910-1911 included also three selections from the plant breeding plats. These strains have been grown from individual plant selections made in 1908 from Leap's Prolific, Golden Chaff, and Tuscan Island. The selections from Leap's Prolific and Golden Chaff appear very promising in the light of the first year's test as they not only exceeded in yield of grain the parent varieties, but also stand at the head of all varieties in the test. The selected strain from Leap's Prolific was first in yield of grain and that from Golden Chaff third.

Oats.—The work with oats last year was a test of twenty-three fall sown varieties. These were the survivors of an elimination by which less worthy varieties fell from the large list grown from 1907 to 1909. Among these varieties the leaders in threshed grain for the past season are Red Rust-proof, Appler, Burt, Bancroft, Virginia Gray, and Culberson, in the order named. For purposes other than yield of grains the Burt variety has many good points over all others tested. It has a good lead over any variety known at this Station for earliness of maturity and can be harvested either for hay or grain in ample time for cowpeas or ensilage corn. It is also a much better variety for hay than many others, having a taller, finer straw which is easier to cure and probably more cleanly eaten by stock than the coarser stemmed kinds.

Peas and Beans.—In 1910 twenty-six varieties of cowpeas, twenty-one varieties of soy beans, eleven varieties of Adsuki beans, and two varieties of Seta beans were tested for comparative yields and to afford a study of varietal characteristics. As it was possible last year to give only a small area to each variety the whole of each plat was reserved to determine yields of grain instead of cutting part for hay, as has been the custom. Whippoorwill was again at the top in production of shelled peas, yielding 18.5 bushels per acre. Blackeye was the first to ripen fully, although New Era and Early Unknown were only a few days later. The India cowpea appears to be an excellent variety for hay. It grows luxuriantly, holds its leaves well and yields with considerable prolificacy a small-podded, well filled fruit, although it is not a heavy yielder of shelled peas. The India cowpea is a small-stemmed, erect to half-trailing sort. In 1910 Townsend, Unknown, and Peerless fruited very poorly, the two latter varieties being nearly barren.

Among the varieties of soy beans in 1910 Hollybrook, Haberlandt, and Jet were in the lead, 22.9, 22.5, and 19.5 bushels per acre. Jet, Guelph, Ebony, Amherst, Kingston, and Haberlandt are the earliest maturing varieties. Mammoth Yellow is a better variety for hay than any of the others. Jet, Amherst, Kingston, Haberlandt, and Guelph do not ripen uniformly and on this account it is practically impossible to

gather all their seed because the pods that are more forward in ripening split and shatter their seed before the other pods mature. These varieties would make an excellent pasture for hogs. They grow in short, thick, heavily fruited bunches, and if planted with a drill or broadcast would make a very heavy yield of seed.

The Adsuki beans were heavy hay yielders in 1909, but produced seed very lightly on account of late planting. However, in 1910 the yield of seed greatly increased and were considerably heavier than yields of the cowpea varieties. No. 17851 yielded 22.9 bushels per acre, while 16791 and 17847 gave 20.2 bushels each. The seed of Adsuki beans matures in about 95 days, which is rather later than cowpeas and considerably earlier than soy beans.

Seta beans, Nos. 21291 and 18444, would have been splendid yielders of hay. The first had a heavy foliage but did not fruit so thickly as the second, which, although of lesser growth, was luxuriantly fruited.

FERTILIZER TESTING.

Main Plats.—The main corn and cotton plats in Soil Fertility Investigations were continued during the past year under a slight modification.

The 1910 results are in general accord with those of former years for cotton, but are somewhat at variance with previous results for corn. With cotton the heavier applications of nitrogen and phosphoric acid give relatively higher returns in value of increase over the cost of the fertilizer than do the normally fertilized plats, or those receiving less than a normal application; but with corn, in 1910, the lighter and less expensive applications are found to be the most profitable. In fact some of the formulas giving the best returns are those in which the expensive element nitrogen has been left out altogether in the application of commercial fertilizer. This may be accounted for by the fact that nitrogen was supplied cheaply and sufficiently in the stable manure, therefore the least expensive application of fertilizer which supplied enough phosphoric acid and potash for the needs of the crop was the most profitable.

Rotation, distance, and culture tests for both corn and cotton have been included in these main fertilizer tests, but their results can be stated only in a more detailed report of the whole experiment.

Phosphate Slag.—The phosphate slag test with cotton was continued last year on the old alfalfa sod. Heavy applications of phosphoric acid and nitrogen gave increased yields, but not in the proportion that may be expected later when the natural fertility of the soil, due to a good supply of organic matter from the alfalfa stubble, is depleted. It is noticeable in the results of this year that lower relative yields were made by plats that did not receive an application of potash in combination with phosphoric acid and nitrogen.

In the slag tests with corn heavy applications of phosphoric acid and nitrogen generally gave increased yields. As with cotton, however, the phosphoric acid and nitrogen seem to give better results when combined with potash since the yields resulting from increased applications of these elements are very often relatively lower when potash is not supplied.

Phosphate Rock.—The usual tests of ground phosphate rock with corn and cotton were carried on last year. From the corn tests the results indicate that while increased applications of phosphoric acid and nitrogen over the normal formula made slightly better yields, the difference was not great enough to justify the increase from an economic standpoint. With cotton, the plats receiving an application of stable manure with Phosphate Rock gave higher yields than the plats that received their nitrogen in the form of dried blood. Two tons of stable manure per acre in combination with 160 pounds of phosphate yielded over 100 pounds more lint per acre than did 204 pounds of phosphate rock in combination with 144 pounds of dried blood.

Miscellaneous Fertilizer Test with Corn and Cotton.—This test is conducted to ascertain the fertilizing value of the various new fertilizing materials that are being put on the market. Under test last year were Solubilized Organic Nitrogen, Potash Manure, Beet Refuse Compound, and Calcium Cyanamid. These were tested in comparison with the better known nitrogenous materials, Dried Blood, Sulphate of Ammonia, and Nitrate of Soda. In production of shelled corn per acre Beet Refuse Compound, Sulphate of Ammonia, Calcium Cyanamid, and Potash Manure gave better results than Dried Blood, Solubilized Organic Nitrogen, and Nitrate of Soda. With cotton the plats receiving an application of Nitrate of Soda, Sulphate of Ammonia, and Dried Blood yielded more lint per acre than any of those treated with the new materials.

Peruvian Guano.—Fertilizing tests with Peruvian Guano alone and in combination with other fertilizing materials were continued in 1910. An application of Peruvian Guano alone at the rate of 250 pounds per acre almost doubled the yield of cotton when checked against a plat receiving no fertilizer. An application of 500 pounds per acre produced more cotton by about one-fifth than the application of 250 pounds. In combination with 37 pounds of Kainit, 97 pounds of Acid Phosphate, and 130 pounds of Nitrate of Soda per acre, 110 pounds of Peruvian Guano more than doubled the yield per acre of the plat receiving no fertilizer.

Top Dressing.—Top dressing experiments with Nitrate of Soda and Sulphate of Ammonia were conducted in 1910 on wheat and corn. The application of both these materials on wheat followed a spring treatment of 200 pounds of Acid Phosphate and 25 pounds of Muriate of Potash per acre. The difference in yield between plats receiving only Acid Phosphate and Muriate of Potash and those receiving an additional treatment of Nitrate of Soda or Sulphate of Ammonia was very slight when only 100 pounds of Sulphate were added. However, when 200 pounds of either Nitrate or Sulphate were applied the results were more marked, with Sulphate of Ammonia causing slightly better yields. An application of Sulphate of Ammonia on corn at the rate of 100 pounds per acre, June 27, increased the yield per acre by between four and five bushels of corn and three hundred pounds of stover.

Variety-Distance.—This test has been conducted with cotton since 1908, but it is discontinued in 1911 and the land it previously occupied given to an experiment investigating the correlation between soil fertility and types of cotton. Previous to 1910 the varieties used in this

work were Culpepper's Improved, King's Improved, and Columbia Long Staple, but last year seed of only Culpepper's Improved and Cook's Improved could be secured in sufficient quantity for planting the test; therefore, the test was limited to a comparison under different distances of planting between these two varieties. The relative yields of these two varieties were not nearly so stable as has been the case with the three varieties previously grown. At 15 inches and 21 inches, Cook's Improved gave the best yield; but at 12 inches, 18 inches, and 24 inches, Culpepper's Improved was the better yielder of the two.

Coöperative Variety Tests.—Coöperative variety testing of corn and cotton was begun in 1910 and gives promise of developing into a very interesting and beneficial line of work. Eight varieties of corn and seven varieties of cotton were selected from the large list of varieties grown on the Station farm and were placed with county demonstration agents for distribution to farmers for a test. Nine tests of corn were made that may be considered fairly satisfactory and reliable.

The results of these are somewhat remarkable in that two varieties, Sanders' Improved and Biggs' Seven-ear, so consistently took such a high stand among the other varieties sent from the Station and the native varieties which were usually included in the test. In four tests Sanders' Improved stands at the head and is third, fourth, sixth, and seventh in the remaining tests. Biggs' Seven-ear is three times a leader, and is second twice, third three times, and fourth once in the nine tests. The results from tests of cotton varieties are not nearly so satisfactory as are those from corn. Tested only four times the results are not sufficiently substantial to mark any variety as a consistent performer, although Toole's Prolific and Cook's Improved made a very good showing.

Coöperative Tillage Tests.—This work was begun in 1909 in coöperation with the Office of Farm Management of the U. S. Department of Agriculture. Considerable land is devoted to this work and includes 144 one-twentieth acre plats located in the Method field and 72 one-twentieth acre plats just northeast of the barn. The work has as yet only progressed so far as to secure basic yields to be used as checks for all the plats when the tillage experiments begin. These yields have been secured with both corn and cotton from the Method field and with corn only from the field near the barn. Two years results in growing basic yields in the Method field plats show a considerable variation in their relative production of corn and cotton. This field is again in corn in 1911.

Planting Seed From Various Parts of the Ear.—This experiment, designed to study the effect of a continued seed selection from certain parts of the ear upon the resulting progeny, has been in progress for three years. From last year's crop, the third successively planted from the butts, tips, middles, and all parts of the ear, the tabulated results show that ears grown from seed from the butt and tip parts of the ear have a decidedly lower percentage of grain than those grown on the plats planted with seed from the middle and from all parts of the ear. The plat planted with seed from the middle of the ear produced more shelled corn but not so much stover as the butt and all-grain plats.

There are other slight differences in yield and characteristics, but they are not sufficiently marked to be considered permanent.

Stability in Weight of Seed Cotton After Picking.—An experiment was designed and carried out in 1908 and 1909 to learn if there was any loss in the weight of seed cotton after picking, when kept stored for some time, and if so, whether the loss occurred from the seed or lint. Close attention was also given to the lint to see if there was any change in its length or tensile strength. As the experiment was conducted rather superficially during these two years no very substantial results were obtained. It was not carried during 1910 on account of lack of time, but will be resumed in the coming fall on a scale broad enough to substantiate whatever results may be secured.

PLANT BREEDING.

Seed Selection with Cotton.—This work begun with cotton in 1908 includes individual plant selections made from the general crop and variety plats of that year for length of staple, earliness, prolificacy, size and uniformity of bolls, double and triple-bolled plants, and for combinations of some of these characteristics. The selections were made with the idea of obtaining improved strains of the parent varieties and to secure good parent stock for cross-breeding, by which method a trial will be made to produce new and desirable varieties. Some very fine plants were produced in 1909 and 1910 from the selections, and enough seed were taken from them for a trial with other varieties in the variety-test of 1911. Culpepper's Improved, the variety grown in the main crop, is under improvement by seed selection. In the breeding plat of this year enough seed will be grown to plant several acres in the main crop of 1912. Several crosses were made by a cross-pollination of the improved strains in 1910, the aim being to combine prolificacy with the non-dropping tendency and general vigorousness shown by some of the improved stock. Most of the crosses were successful and seed from them will be planted and selection begun from their progeny for the desired characters.

Seed Selection with Wheat.—The work with wheat is similar in outline to the improvement by seed selection with cotton. The original selections made in 1908 have been continued and enough seed were secured from the most promising ones in 1910 to plant several plats for trial in the variety test. Selections from Leap's Prolific and Golden Chaff are very promising strains. Given an area of one-tenth acre in the variety test this year they have made an excellent showing in yield of grain.

Respectfully submitted,

W. C. Etheridge,
Associate Agronomist.

REPORT OF DIVISION OF CHEMISTRY.

I have the honor to submit the following report of the Division of Chemistry for the year ended June 30, 1911:

During the year the Division was engaged in work along the following lines: Soil Bacteriology in coöperation with the Division of Bacteriology, Toxicity of Cottonseed Meal in coöperation with the Animal Husbandry, Veterinary and Pathological Divisions, Inorganic Plant Constituents in coöperation with the Agronomy Division, Inorganic Plant Constituents and Tannin in coöperation with the Referees of the Association of Official Agricultural Chemists, Sugar Beet Culture in coöperation with the Bureau of Plant Industry, Testing Reagents and Methods of Analysis, and miscellaneous work.

Soil Bacteriology.—The Division has made 2,687 determinations in 1,014 samples of soils and solutions as follows:

Nitrogen as ammonia by magnesium oxide method	62
Nitrogen as nitrates, phenol disulphonic acid method	474
Nitrogen as nitrates, Tiemann Schulze method	409
Nitrogen as nitrites, Griess method	864
Nitrogen as nitrites and nitrates, Withers and Ray method	834
Nitrogen total by Kjeldahl method	20
Humus	12
Volatile organic matter	12
	2,687

With the Division of Biology it has published the following:

Studies in Soil Bacteriology, Nos. 2 and 3 in the North Carolina Station Report for 1908-09; Studies in Soil Bacteriology No. 4 in the North Carolina Station Report for 1909-10, and in the Centralblatt für Bakt. Band 27. The manuscript for Studies in Soil Bacteriology No. 5 is submitted herewith for publication. An abstract of it was read before the May, 1911, meeting of the North Carolina Academy of Science.

Toxicity of Cottonseed Meal.—This Division has prepared 356.9 kilograms of 17 kinds of feed for 203 Belgian hares. Twelve of the feeds had been used previously and five were used this year for the first time. In connection with it there were 161 determinations of phosphoric acid. Two important conclusions have been reached as a result of the experiments and the manuscript will be submitted for publication very soon.

Inorganic Plant Constituents.—This division has made 218 determinations in 50 samples of portions of the cotton plant sent for analysis by the Director. These determinations were:

Nitrogen total by Kjeldahl method	40
Phosphorus pentoxide total	36
Calcium oxide total	10
Moisture	132
	218

Association of Official Agricultural Chemists.—This Division has made 14 determinations in three samples sent out for analysis by the

Referee on Inorganic Plant Constituents, and 191 determinations in the four samples sent out by the Referee on Tannin. Dr. Ray has served as Associate Referee on Tannin during the year. During the year the writer presided over the Washington meeting of the Association (November 10, 11, and 12, 1910) and as President read an address upon "The Teaching of Chemistry in American Agricultural Colleges," which was published in *Science*, vol. 33, pages 849-855, and in the Proceedings of the Association (Bulletin No. 137 Bureau of Chemistry, pages 91-97).

Sugar Beet Culture.—Experiments conducted in various parts of the United States have indicated that the most profitable areas for sugar beet culture were within the zone having a mean summer temperature of 70° F. In 1898-9 (Bulletin 180, May, 1901) the writer conducted experiments in North Carolina which resulted in producing for the first time in the State a beet containing 14 per cent of sugar, and prepared a bulletin showing the probable sugar beet areas in the State. In continuation of that work and in coöperation with the Bureau of Plant Industry of the U. S. Department of Agriculture, this Division has distributed this year sugar beet seeds to 150 residents of the 12 counties in Western North Carolina which seem best adapted to the growth of the beet.

Testing Reagents and Methods.—This work has involved 199 determinations as follows:

Moisture	12
Chlorine gravimetrically	8
Oxygen	12
Nitric oxide	15
Nitrogen as nitrates phenol-disulphonic acid	46
Nitrogen as nitrates, Tiemann Schulze	88
Nitrogen as nitrates and nitrites, Withers and Ray	8
Sulphur trioxide gravimetrically	2
Sulphur trioxide volumetrically	8
	199

During the year the writer and F. W. Sherwood read a paper before the January, 1911, meeting of the North Carolina section of the American Chemical Society, proposing a modification of the Tiemann Schulze method for determining nitrates and nitrites which has proven very satisfactory in our hands. The paper is submitted herewith for publication.

Miscellaneous.—The Division has made 83 determinations in 34 samples, as follows:

Soils	7
Feed	1
Fertilizing material	12
Water	1
Building lime	3
Marl	2
Fats	4
Guinea pig urine	4
	34

The determinations were:

Nitrogen	20
Potassium oxide	6
Phosphorus pentoxide	4

Calcium oxide	12
Magnesium oxide	2
Carbon dioxide	10
Acidity	7
Total solids	2
Volatile matter	4
Specific gravity	4
Melting point	4
Albuminoids	4
Sugar	4
	83

During the year Dr. Ray was elected Secretary of the North Carolina Section of the American Chemical Society. The writer was elected Vice-president of the North Carolina Academy of Science, and a member of the General Committee of the Agricultural Section of the VIII International Congress of Applied Chemistry.

The writer read before the Southern Commercial Congress (Atlanta, Ga., March 10, 1911) a paper upon The Relation of Climate and Rainfall to Southern Agricultural Monopolies, which was published in *The Tradesman* for March 16, 1911.

The Division is moving into the new and more commodious quarters which have been provided for it in the new Engineering Building. For this increased space and improved equipment we wish to express our thanks to you, President Hill, the Board of Trustees, and General Assembly.

Very respectfully,

W. A. Withers,
Chemist.

REPORT OF DIVISION OF BIOLOGY.

I beg to submit the report of the division under my charge for the fiscal year now closing:

In Plant Pathology the chief subject under investigation has been lettuce sclerotiniose. The method of treatment deduced from laboratory investigations has now been given a thorough trial in the field and proved successful. The results have been presented in practical form in Bulletin 217. A more extended exposition of the technical work and results is now in the hands of the Director, ready for publication. A popular Bulletin, No. 212, has been prepared and printed. This discusses smuts, especially those of the cereals, and gives methods of treatment. A popular article, Progress in Control of Plant Diseases, was published in *Popular Science Monthly.*

Okra wilt (Fusariose), similar to cotton wilt, was found near the college, and received some attention (page 70).

A new buckwheat disease (Rhizoctoniose) has also been the subject of study.

Hundreds of letters relating to plant disease have been received and answered. Many of these were accompanied by specimens and diagnoses were made and treatment prescribed. Work has been continued on apple and crucifer diseases.

In coöperation with the National Department of Agriculture extensive plans have been made for study of the Granville tobacco wilt and work has been begun. Work on a plant disease survey in coöperation with the National Department of Agriculture has been continued.

Breeding for Disease Resistance.—Breeding for resistance of melons and tobacco against wilts has been continued along the lines reported in previous years.

Soil Bacteriology (in coöperation with the Division of Chemistry).—The Soil Bacteriological Survey undertaken some years ago has now been completed and the results are nearly ready for publication, as are also a number of miscellaneous observations on soil bacteriology. The point receiving major attention now relates to the relative values of ammonia and nitrate nitrogen to the growing plant. This subject has been under study some years, but much work remains yet to be done. The associative action of bacteria in soil, especially of nitrifiers and denitrifiers, both with and without organic matter, is also subject of study.

Respectfully submitted,

F. L. Stevens,
Vegetable Pathologist and Soil Bacteriologist.

REPORT OF POULTRYMAN.

I beg to submit the following report of the work in the Poultry Division for the year ending June 30, 1911:

FEEDING EXPERIMENTS.

The feeding work outlined in last year's report has been taken up. These feeding experiments are to test different rations for egg production and for their effect on the health and breeding quality of the fowls. It was planned to use 12 pens of fowls in this work, feeding six different rations. Six of the pens to be ordinary size yards, such as the average poultryman would use, and six lots of approximately half an acre each in which farm crops are grown. On account of lack of room two of the large lots could not be used and to balance the experiment two of the small pen lots were dropped, leaving eight lots of fowls on four different rations. A great many farmers still depend entirely on corn for feeding their poultry. This feed will, under some conditions and at certain seasons, give very satisfactory results, but when the fowls are dependent on the feeder for all they get to eat it will not give good results. In order to test this matter corn only was fed to one pen in each size yard. Wheat alone was fed to two pens. The two other rations were composed of both grain and dry mash. The grain was the same in each case, being two parts corn and one part wheat. The mash in one case was equal parts by weight of corn meal, wheat bran, and cottonseed meal. In the other it was four parts corn meal, four parts wheat bran, two parts meat meal, and two parts bone meal.

The small yards were set in Bermuda grass, which gave no green feed during the winter, but an abundance during the summer. To keep the grass in these lots in the best condition for the hens during the summer it was pastured just enough to keep it from getting old and tough. In the large lots winter oats was grown for hay. This crop gave good grazing during the winter months and was harvested about June 1st.

These experiments are planned to run nine months, from January 1 to September 30, and are, therefore, not completed at this time. For the winter period there was a saving in the cost of production of from twenty to thirty-three and one-third per cent in the large yards with the green crop over the same rations in the small yards. With the first three rations mentioned the saving was approximately one-third and on the last ration one-fifth.

The last ration, which contained the meat meal and bone meal, was the only one that could be considered satisfactory as with the others the eggs cost from 22 cents per dozen to 36 cents per dozen, while with this ration for the three months from January 1 to March 31, the cost was 12 cents per dozen in the large yard and 14.4 cents per dozen in the small yard.

In all cases except the meat meal and bone meal ration, the fowls in the large lots laid more eggs than those in the small lots. Those fed meat

meal and bone meal in the small yard laid a few more eggs than those in the large lot, but the cost was greater and the profit less in the small yard.

The fertility and hatchability of the eggs has not been fully tested at this time, but in those incubated the results were better from the hens having the meat meal and bone meal ration than any of the others, but were not as good as they should be, even from these lots, and while the ration was fairly satisfactory from the standpoint of egg production it is thought that it might be improved for breeding purposes by cutting down the animal feed in the ration. Just what would be the best proportion considering both egg production and breeding ability has not yet been determined.

Experimental work in the feeding of growing chickens has been outlined for the summer and will be started as soon as the crops are ready. These are divided into two groups of three lots each. One to be a test of different rations on the same grazing conditions and the other of different grazing crops where the same ration is fed.

It is planned to extend the feeding experiments for the next year by the addition of more of the large lots. Some changes in the rations will also probably be made, based on the results obtained in this work.

There is a large and growing demand throughout the State for information pertaining to poultry. The Poultryman attended twenty-eight Farmers' Institutes during last summer and two short course schools held during the winter by the State Department of Agriculture, and judged the poultry at several fairs. The policy of this Division in regard to judging is to help in any way that it can the newly organized and smaller Agricultural Societies which do not feel able to pay for the services of a poultry judge.

The demand for breeding stock and eggs for hatching during the year has been the largest in the history of the Division. The correspondence which comes to the Poultryman has also greatly increased from year to year.

Respectfully submitted.

J. S. Jeffrey,
Poultryman.

REPORT OF DIVISION OF HORTICULTURE.

I herewith submit a report of the work of the Horticultural Division for the year ending June 30, 1911:

SELF-STERILITY OF DEWBERRIES AND BLACKBERRIES.

Our work on this problem has been continued during the past year, and some very important results were obtained. These results corroborate those of the previous year. We have found that the following varieties of dewberries are self-sterile: Premo, San Jacinto, Chestnut, Manatee, Rogers, White, Lime-kiln, and Monroe.

The following varieties are self-fertile: Lucretia, Austin, Cox, Ruth, and possibly Grandee.

One very interesting and important fact discovered is, that one self-sterile variety will successfully cross-fertilize another self-sterile variety of dewberry. This means that the pollen of self-sterile varieties is good, that is, it will germinate on the pistils of other varieties. It also germinates readily in a sugar solution in the laboratory. As yet we have not been able to determine why this pollen will not fertilize the pistils of the same variety. Our work on this problem will be continued.

SELF-STERILITY OF ROTUNDIFOLIA GRAPES.

We have given a large amount of our time during the past year to this problem. We have found that all the varieties of this species now in general cultivation are self-sterile; that is, the fruit can not develop unless the flowers are fertilized with pollen from a male muscadine vine. This self-sterility is due to the fact that the pollen of the cultivated varieties is worthless and can not germinate under any conditions. The results of this work have been published in Bulletin 209 of this Station.

One wild vine has been found in our work which appears to be an exception to this rule. If this vine should prove an exception it will be a valuable discovery. Our work on certain phases of this problem will be continued.

A STUDY OF ROTUNDIFOLIA GRAPE HYBRIDS.

The Rotundifolia grapes are the most valuable in the South. But in some respects they are very defective. These imperfections must be eliminated by breeding. Just how this can be done is still a question. Hence we have made many crosses, and are making a careful study of the hybrids. This is to determine the fundamental laws which govern such hybrids. We have already obtained some very valuable data; and have found one fundamental law which governs such hybrids. This law can be stated as follows: When the Scuppernong is fertilized with pollen from a white male vine the seedlings resulting from such seed will produce white fruit; and when the Scuppernong is fertilized with pollen from a black male vine the seedlings resulting from such seed will produce dark fruit.

Hundreds of seedlings from last year's crosses are just beginning to grow and some valuable data will be obtained from these this year.

SELF-STERILITY OF PERSIMMONS.

We will begin this year an extended study of self-sterility and self-fertility in Native and Japanese persimmons. This is to determine what varieties are self-sterile, what varieties are self-fertile, and what varieties or forms are the best pollinizers for the self-sterile varieties. Also to detemine the cause of seedlessness in many persimmons.

A STUDY OF THE INFLUENCE OF PLANT FOOD ON POLLEN.

In connection with our studies on self-sterility of plants we are trying to determine the influence which the elements, nitrogen, phosphorus, potash, magnesium, and calcium, have on the formation and character of pollen. At present the tomato plant is being used for this study. The work on this problem will be continued.

DOUBLE BLOSSOM OF THE DEWBERRY AND BLACKBERRY.

The work on this problem has been practically completed. We have found that this trouble is due to a fungus disease, known as *Fusarium rubi,* Winter. The results have been prepared for publication.

Certain phases of the subject, such as a study of varieties subject to the disease, and best methods of controlling the disease, will be continued this year.

PRUNING APPLE TREES.

The experiment on pruning young apple trees is being continued. This work has not progressed far enough to warrant any conclusions.

PUBLICATIONS.

During the year this Division has published Bulletin 209, entitled, "Self-sterility of the Scuppernong and Other Muscadine Grapes," and has recently submitted a report on "Double Blossom of the Dewberry and Blackberry."

Thanking you for the interest you have shown in our work, I beg to remain, Respectfully yours,

F. C. Reimer,
Horticulturist.

REPORT OF DIVISION OF ANIMAL HUSBANDRY.

I beg to submit the following report of the Animal Husbandry Division for the fiscal year ending June 30, 1911:

The major line of work of the Division for the past year has been a continuation of the investigations relating to the toxicity of cottonseed meal in swine. Guinea pigs and rabbits have been used largely during the last year to determine the promising lines of work. These experiments are then duplicated on large hogs as far as possible.

A study of the effect of Sea Island cotton seed and Sea Island cottonseed meal has been under way most of the year. From all indications the Sea Island cottonseed meal is equally as toxic as the Upland meal. A decision has not been reached regarding the toxicity of Sea Island seed. In this work two calves have been fed cottonseed meal for the purpose of determining the difference in the effect of the meal on calves and swine.

The experiment on feeding cottonseed meal to horses and mules has been completed, and the results have been reported in Bulletin 215. Also a general bulletin has been issued giving some practical information concerning the use of cottonseed meal for work stock. It also contains a brief report of the work done on this subject by other Stations, and some data from practical farmers who have used this meal extensively. The important conclusions drawn from the experiments at this Station are as follows:

Cottonseed meal may be used in limited quantities in the rations for work stock with satisfactory results, although in some cases animals will refuse it even after repeated attempts to feed it.

It should never be undertaken to feed cottonseed meal alone. It is a very concentrated feed and for this reason it should be used only as a supplement to carbonaceous feeds, such as corn.

The meal should always be fed with some finely divided concentrate, such as corn-and-cob meal, wheat bran or brewers' grains. The more thorough the mixture of cottonseed meal with the basal feed the more satisfactory the results will be.

The amount of cottonseed meal fed daily should rarely exceed two pounds per animal. A safe guide to follow will be to feed one-fifth of a pound of the meal per hundred pounds of live weight. Draft stock materially exceeding one thousand pounds in weight may use two and one-half and possibly three pounds per day in exceptional cases.

Based on the ration for a work animal of average weight, the amount of cottonseed meal fed should not exceed fifteen per cent of the total ration by weight. As a general thing the results will be more satisfactory if only ten to twelve per cent of the ration is composed of this meal.

The results obtained by the writer during three years experimental work show that no ill-effects will arise from the use of cottonseed meal if it is used with judgment, however, if it is unduly increased it will not only be refused but will injure the condition and working capacity of the animals.

The chief thing in mixing a cottonseed meal ration is to use the meal in connection with feeds which can be thoroughly incorporated with it, thus avoiding any quantity of the meal sifting through the ration to the bottom of the feed trough. Wheat bran is excellent for this purpose, although its use increases the cost of the ration.

Only bright, fresh colored cottonseed meal should be used. Meal which is dark yellow in color is likely old and somewhat musty. This stale condition of the meal no doubt at times is responsible for animals refusing it.

Cottonseed meal is an excellent laxative and for this reason it is desirable to feed with corn, aside from the fact that it furnishes the deficiency of protein in this feed.

The effect of cottonseed meal on the coat of the animal is to make it smooth and glossy, having the same effect in this respect as linseed meal.

The present price of cottonseed meal, which will average about $30.00 per ton, precludes any reduction in the cost of the ration. Its principal value must be derived from the beneficial effect on the coat, condition, and digestive system of the animal and in the enhanced value of the manure resulting from its use.

The experiments on feeding cottonseed meal, corn silage, corn stover, and cottonseed hulls to beef cattle will be reported in Bulletin 218. The chief objects of this experiment were to determine the difference in value of the three roughage feeds, namely: corn stover, corn silage, and cottonseed hulls.

Cottonseed hulls gave the largest gains both years, but the dressing percentage of the cattle fed this roughage was lower than either of the other lots the last year of the experiment. The cattle were valued as follows when finished for market: Lot 1, fed corn stover and corn silage, $5.90 per hundred; lot 2, fed corn silage, $6.00 per hundred, and lot 3, fed cottonseed hulls, $5.72½ per hundred. The first year the cattle fed corn silage made the cheapest gains, those fed cottonseed hulls the second cheapest gains, and the cattle fed corn silage and corn stover the costliest gains. The second year the cattle fed cottonseed hulls made the cheapest gains, those fed corn silage the second cheapest gains, and the cattle fed corn stover and corn silage the costliest gains, the same as the first year. With the two former roughages the results were reversed the first and second year. The indications are that the farmer should save a portion of his corn crop in the form of silage, and discontinue buying cottonseed hulls, which are becoming more expensive each year.

In conjunction with the publication of these experimental results a general bulletin will be issued on the Feeding and Management of Beef Cattle.

The writer contemplates some further work along the line of feeding cottonseed meal to beef cattle. The work planned includes the following:

(1) A determination of the most profitable amount of cottonseed meal to feed under Southern conditions; (2) a determination of the value of corn silage in prolonging the period of feeding and increasing

the amount of cottonseed meal which can be fed; (3) the influence of these various feeds on the quality and selling price of the carcass, and (4) the influence of the size and weight of animal on the total amount of cottonseed meal which can be fed, and the amount which can be fed per hundred pounds live weight.

During the last year six pure-bred Berkshires were added to the Station herd. A start has been made in Shropshire sheep, which will be used in the formation of a breeding herd for experimental work.

A considerable number of improvements have been made in the Animal Husbandry Division, which will aid in the efficiency of the experimental work.

Forage crops for swine are being grown continuously to determine the crops best adapted to the State for swine production.

The crops which are most promising are rye, rape, oats, Canada field peas, cowpeas, peanuts, and sweet potatoes.

Considerable correspondence comes to the office relating to the adaptability of the State for stock growing, and the feeding, care and management of live stock.

Respectfully submitted,

R. S. Curtis,
Animal Husbandman.

REPORT OF DIVISION OF DAIRY HUSBANDRY.

I beg to submit the following report of the work of the Dairy Division of the Station for the year ended June 30, 1911:

The experimental work during the past year has been confined to cottonseed meal as a suitable feed for calves and growing heifers.

In the first experiment twelve heifer calves ranging in age from five to ten months were selected and divided into two lots or six each. Each lot received the same amount of corn silage and hay. For a grain ration lot 1 was fed a mixture of corn, oats, and wheat bran in equal parts by weight. Lot 2 was fed a mixture of cottonseed meal, oats, and wheat bran. The results showed that four of the six calves in lot 2, all four of which were under ten months of age, either made no gain at all or lost considerable during the first two months of the feeding. In addition they appeared very unthrifty. The two calves in lot 2 that were ten months old made satisfactory gains and growth, as did all of the calves in lot 1. At the end of two months all four of the young unthrifty calves in lot 2 were transferred to the grain ration of corn meal, oats and wheat bran, and at once began to improve, so that they made reasonably good gains from that time on. The results seem conclusive that cottonseed meal should not be fed to calves under ten months of age.

Another young bull calf was fed cottonseed meal mixed with skimmilk, four ounces of the meal per day being supplied at the start, with the amount gradually increased as the calf became older, so that he was receiving one and one-half pounds per day when he died after being on feed seventy-one days.

From the results secured it seems evident that cottonseed meal should not be fed to calves under any consideration before they are at least ten months old.

A Bulletin on the feeding and management of the dairy herd was published during the year.

Respectfully submitted,

JOHN C. MCNUTT,
Dairy Husbandman.

REPORT OF ENTOMOLOGIST.

I beg to submit herewith a report of the work conducted for the Entomological Division for the year ended with June 30, 1911:

During the summer and fall of 1910 most of my Station time was devoted to a study of the life history and habits of the two melon worms, *Diaphania nitidalis* and *Diaphania hyalinata,* this being the same project to which considerable time was given in 1909. Most of this investigation was conducted at West Raleigh. This consisted mainly in securing a large number of records of the development of the worms from egg to adult stage, the duration of the egg, larva and adult stages, breeding of parasites and predaceous insects, determination of the general habits of the larvæ and adults, egg-laying, etc. Field observations were also made at frequent intervals. Two trips were made in July, 1910, to the cantaloupe section of Robeson and Scotland counties. A full report of this investigation has been written and published as Experiment Station Bulletin 214. The bulletin contains technical descriptions of eggs and worms in all stages of development and description of the adult stages, as well as records of the breeding experiments which served to demonstrate the length of the life cycle for both species and the usual number of generations each year. The report shows that this pest is one which can be avoided by getting an early maturing crop of cantaloupes, for it was learned that the worms of the first and second generations, which mature during June and July, are not sufficiently numerous to cause noticeable injury, and the third generation, when the worms become destructive, does not develop until after about July 15, when an early cantaloupe crop should be largely matured.

The melon worm, *Diaphania hyalinata,* proved to be of little importance, compared with the other species. It appears later and seems to prefer to feed on the foliage, especially of summer squash when that plant is available. The report also indicates that parasites and natural causes are evidently keeping the melon worm down to small numbers.

An important result of the investigation was the determination of the value of summer squash plants as a trap for the pickle worm, *Diaphania nitidalis,* which is the species which the cantaloupe grower has to fear. The report shows that where summer squash plants were distributed through the cantaloupe fields that these served to attract nearly all the worms until about the first of August. The efficiency of this trap plant was fully demonstrated; one illustration of the benefit derived, as stated in Bulletin 214, is sufficient to prove this statement:

On July 27, 1910, in a four-acre field of cantaloupes, about 400 hills of summer squash were present, and when examined, proved to contain an average of 65 worms to each hill, while the maturing cantaloupes on all sides were practically free from worms. In fact, only one cantaloupe showed worm injury. However, at that date the summer squash were getting in very bad condition, practically ruined by worms, and as no late plantings had been provided their efficiency as a trap plant did not continue. Two weeks later the cantaloupes showed about ten per cent injured by worms. In ordinarily early seasons the cantaloupes

around Raleigh are all gathered by August 1, hence the summer squash as a trap may be used successfully. Other fields of cantaloupes not protected by summer squash showed as high as 75 per cent destroyed by worms on August 1, when the field above mentioned had sustained practically no injury.

The investigation proved conclusively that cantaloupe growers should depend mainly on getting an early crop, or they should provide successive plantings of summer squash to attract the egg-laying moths, if their crop is to mature later than July 15.

Parasites and predaceous insects were found to be of some help in suppressing the melon worms, but they can not be expected to be numerous until late in the season, and their real value lies in destroying many worms that would otherwise live during the winter.

The melon worm project was not taken up again in 1911, because of a new project, the Corn Bill Bugs, which has required all of the writer's time and attention.

The detailed report of the Corn Bill Bug investigation up to July 1, 1911, is submitted herewith as a special article. This report shows that careful life history studies of the bill bugs have been started, but no records are yet complete.

MISCELLANEOUS WORK AND RECORDS.

In addition to the work on Adams Projects the writer has attempted to make observations and notes on all the injurious insects brought to his attention. During the past year there have been no serious outbreaks of insect injury except as recorded below. Some specimens of injurious insects, and a few common insects collected from one source or another, have been added to the insect collection. Notes concerning the occurrence of some insects of general interest have also been recorded.

The Spring Grain Aphis, *Toxoptera graminum,* has been unusually numerous and injurious in the oat and wheat fields on both the Station and College farms this past spring. Some fields were destroyed so that they were not harvested. This aphis injury appears to have been general over the State, and is largely accounted for by the weather conditions, a cool, damp spring, which always favors an increase of the aphids. When settled dry hot weather commenced, the natural parasites and predaceous lady beetles became numerous and destroyed most of the aphis, but not until after great damage had been done.

Corn Flea Beetles of two species, *Chætocnema parcepunctata* and *C. pulicaria,* were very abundant, and were destructive to young corn during May and June. One six-acre field on the College farm was injured so severely as to require replanting, and the writer noticed the beetles in great numbers in practically all the corn fields in this vicinity. Reports of their presence in other localities were also received.

Red Spiders, *Tetranychus gloveri,* have recently appeared in remarkable numbers in gardens in this locality and many reports have been received of their presence on cotton. This pest—not a true insect—is favored by continued hot dry weather, such as has prevailed during June, 1911. In gardens where running water is available, frequent drenching of plants serves to keep this pest in control. In cotton fields,

or where water can not be used, a spray of one pound of laundry soap in four gallons of water is effective. The concentrated, commercial, lime-sulphur solution diluted one part to one hundred parts of water is an effective spray, and ordinary flour of sulphur, one ounce in one gallon of water will kill a large per cent of the red spiders.

The most important work of the year, except the Adams projects—melon worms and corn bill bugs—was that undertaken to suppress the *house fly, Musca domestica,* which was unusually abundant and troublesome during May and June. Attention was first directed to this problem on May 22, when Director Williams sent out a circular letter to the residents of West Raleigh, asking their coöperation in an attempt to make this township a sanitary district. Reports of typhoid fever and the undoubted presence of many flies, were responsible for this action. At Mr. Williams' request the writer commenced an investigation to determine the principal breeding places of the flies, and later, as recorded elsewhere, a method of poisoning flies with formaldehyde was successfully demonstrated. Newspaper articles concerning flies were written and appeared prominently in the Sunday editions of the Raleigh *News and Observer* and in the *Raleigh Daily Times.* On this date, June 30, the people of Raleigh and West Raleigh have cleaned up many breeding places by using formalin as a fly poison, and already the good results of the campaign are being spoken of. The flies around the College dairy and horse barns have been reduced to very small numbers by the combined work of removing the stable manure each week or oftener, and by poisoning thousands of flies with the formaldehyde. A report of the work with houseflies, up to the present date (the work is still in progress) is submitted herewith as a special article.

BULLETINS AND NEWSPAPER ARTICLES.

The following have been written by the Entomologist during the year:

Bulletin 214, "Two Important Cantaloupe Pests." This bulletin records the work of two seasons with the two melon worms spoken of in the report.

Circular Bulletin 23, "How to Suppress Houseflies." This circular was sent to all the newspapers in the State, with request for early publication.

For newspapers the following articles have been supplied: "Facts Concerning the Housefly," "Where Do Houseflies Breed?" and "The Housefly Must Go."

Other short articles were written and appeared in the daily papers concerning the success of the formalin poison treatment for killing houseflies.

Two articles, namely "Formalin Poison for Houseflies" and "Breeding Places of the Housefly" were written for the State Board of Health for publication in their monthly bulletin for July.

CORRESPONDENCE.

Letters received and answered have increased in number since my last report. Some of these letters have required very long replies because of

having no bulletins on the subject that would answer. Letters concerning household insects such as ants, roaches, fleas, etc., and others relative to insects not usually discussed in bulletins, have increased the correspondence noticeably.

ENTOMOLOGICAL LITERATURE.

Additions to the entomological library have been made largely by bulletins. The Journal of Economic Entomology, the official organ of the Association of Economic Entomologists, has been secured in complete form to date. It is desirable to make additions in the form of complete files of older entomological publications, which can only be secured by purchase.

Respectfully,

R. I. SMITH,
Entomologist.

REPORT OF DIVISION OF VETERINARY SCIENCE.

I beg to submit herewith a report of the work of the Veterinary Division for the fiscal year ending June 30, 1911:

In coöperation with the Animal Husbandry, Chemical and Animal Pathology Divisions work upon the study of the injurious effects of cottonseed meal feeding has been continued.

Clinical observations have been made upon 26 hogs fed treated and untreated cottonseed meal and upon one calf fed 1 per cent to 2 per cent of its body weight of cottonseed meal daily.

Necropsies were held upon 18 guinea pigs, 40 rabbits, and 3 hogs, dead from cottonseed meal feeding. Sections of various internal organs were saved and turned over to the Animal Pathology Division for histological examination.

Some blood examinations were made to determine any alteration in total solids, in amount of hemoglobin and in the differential count of leucocytes.

Numerous enquiries relative to diseases of livestock were answered. A much larger number of enquiries than heretofore were concerning the serum vaccination against hog cholera. These were referred to the State Department of Agriculture, which Department is producing the serum.

Twenty-four head of the Experiment Station hogs were injected with the serum April 18, 1911, when cholera made its appearance in the neighborhood and some 40 head of hogs were lost by one person. No signs of the trouble has as yet appeared in our herd.

A number of specimens of damaged feed, of animal parasites, and of diseased tissues were received for examination.

Respectfully submitted,

G. A. Roberts,
Veterinarian.

REPORT OF DIVISION ANIMAL PATHOLOGY.

I beg to submit the following report of the Animal Pathology Division for the period between September 1, 1910, and June 30, 1911:

The work has been confined to the cottonseed meal project in conjunction with the Chemical, Animal Husbandry, and Veterinary Divisions. A large number of small experimental animals have been fed with the various extracts, fractions, etc., prepared by the Chemical Division, both forced and natural feeding being used. It was the intention to make a thorough and detailed study of the postmortem and pathological lesions found but owing to the unsatisfactory conditions attending the unsanitary quarters and equipment for the animal room this plan had to be temporarily abandoned. The same state of affairs caused the postponement of the experiments as to the possibility of immunizing small animals against the cottonseed meal poisoning; study of the conditions of the blood in cottonseed meal poisoning, etc.

More satisfactory quarters and equipment for the animal room have been obtained and the above lines of work are now in progress with every indication of obtaining satisfactory results.

A small amount of time was used during the year in a study of fowl cholera. Besides assisting in repressive measures some sixty-odd autopsies were made, symptoms and lesions noted, and the causative organism studied to some extent.

WORK CONTEMPLATED.

The cottonseed meal project will continue to occupy the major part of the time of the Pathologist. The experiments already under way and those to follow as the work progresses will be coöperative work with the other Divisions working on this project. The particular field of this Division will be the supervision and care of the animal room and animal feeding observations, autopsy and pathological study of the smaller experimental animals and the planning and execution of the experiments on this project from the pathological and physiological side.

It is hoped that opportunity and facilities will be granted for work on vaccination against fowl cholera.

The usefulness of this and of the Veterinary Division would be enlarged were it possible to undertake the diagnosis in the laboratory of the cases brought to the attention of the Veterinarian, most of which are either too indefinite or of a character which renders it impossible to make a diagnosis through the brief description of the symptoms contained in a letter.

The research work of this Division would be more valuable were it possible to coöperate with the State Veterinarian in the study of the infectious diseases which he encounters in his frequent visits to different parts of the State. In the absence of a State Veterinary Laboratory, the Animal Pathology Division of the Station seems to be the logical place to undertake this work, and it is hoped that something along this line may be undertaken in the near future.

Respectfully submitted,

Jos. D. Cecil,
Animal Pathologist.

RECEIPTS AND EXPENSES.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATIONS, 1910-1911.

DR.

To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ending June 30, 1911, under Acts of Congress, approved March 2, 1887, and March 16, 1906:

Hatch Fund	$15,000.00
Adams Fund	15,000.00

CR.

	Hatch Fund.	*Adams Fund.*
By salaries	$6,186.94	$10,656.98
Labor	2,588.75	1,129.28
Postage and stationery	266.57	183.22
Freight and express	188.37	108.22
Heat, light and water	295.70	37.20
Chemical supplies	42.70	466.21
Seeds, plants and sundry supplies	573.84	113.49
Fertilizers	892.27	439.44
Feeding stuffs	1,689.21	329.56
Library	134.13	206.10
Tools, implements and machinery	679.39	341.81
Furniture and fixtures	137.22	51.93
Scientific apparatus	4.55	283.15
Live stock	609.65	275.75
Traveling expenses	408.49	288.24
Contingent	29.00	.....
Buildings and land	273.22	89.42
Total	$15,000.00	$15,000.00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the North Carolina Experiment Station for the fiscal year ending June 30, 1911; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $30,000, and the corresponding disbursements $30,000; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving nothing.

And we further certify that the expenditures have been solely for the purposes set forth in the Acts of Congress, approved March 2, 1887, and March 16, 1906.

(Signed) W. E. DANIEL,
JNO. O. ELLINGTON,
O. MAX GARDNER,
Auditors.

(Seal.)

Attest: A. F. BOWEN, *Custodian.*

SCIENTIFIC PAPERS

DOUBLE BLOSSOM OF THE DEWBERRY AND THE BLACKBERRY.[1]

F. C. Reimer and L. R. Detjen.

Ever since dewberries and blackberries have been grown in America on a commercial scale the marketable crops of certain varieties have been considerably reduced by a serious disease commonly known as Double Blossom. Usually one or two good crops of berries are gathered and then the trouble begins. The berry patch becomes more and more infested and rapidly declines in productiveness until soon the whole field becomes unprofitable.

Fig. 1.—Early stage of the "witches broom" on Lucretia dewberry. The two canes on the left show the broom formation; while the one on the right shows the normal growth.

The consensus of opinion among fruit growers generally is that spraying with fungicides has no effect on the spread of this disease. This leads some to believe that the double blossom is not caused by a microörganism, but that it is a peculiar physiological condition of the leaf and flower buds.

[1]Specimens of this fungus were sent to Dr. M. T. Cook of the Delaware Station, who identified it as Fusarium rubi, Winter.

To determine the cause of the trouble an experiment was planned and begun in the spring of 1908. Because of the two views prevalent as to the cause of the double blossom two lines of investigation were followed, viz.: physiological and the pathological.

Physiological Investigation.

The physiological investigation was conducted principally along four lines, to determine—

(1) Whether the double blossom is caused by severe pruning.

(2) Whether the witches broom is the result of a luxuriant outgrowth from frost-bitten branchlets.

Fig. 2.—Double blossom on the Wilson blackberry.

(3) Whether the witches brooms and the sterile blossoms are the result of immature and imperfect scale-buds.

(4) Whether insects, especially aphids, are indirectly the cause of the brooms.

Effect of pruning on double blossom.

In the spring of 1909 a field of Wilson blackberries was laid off into six plats of three rows each. When the young shoots were sufficiently

high the canes on each of the plats were pruned down to 12, 18, 24, 30, and 36 inches respectively, and the sixth plat was left unpruned as a check.

No rosettes or brooms developed in either of the plats. Pruning then gave us only negative results.

EFFECT OF COLD ON DOUBLE BLOSSOM.

If the witches broom is the result of a luxuriant outgrowth from frost-bitten branchlets then it could be easily produced artificially.

It was frequently noticed that whenever a leaf dropped prematurely, either from disease or otherwise, the axillary bud would begin growth. The resulting immature shoot, being tender and exposed to the elements of winter, was frequently killed back nearly to the cane whence it sprung. The tip being killed, new growth would push out from the basal or scale-buds of the injured member and since severe winter pruning induces wood growth the result would be a witches broom.

To investigate we clipped off on June 21, 1909, one whole crop of leaves from every third row of the Wilson blackberry patch, and on July 19 a second crop, with the exception of that from the first row. No witches brooms were formed on any of the rows as a result of this kind of treatment.

To determine whether frost is the cause of the formation of the witches broom young canes from badly infected patches were transferred to the greenhouse.

The transplanting occurred in October, some time before frost. These canes, however, developed brooms just as freely as those left out of doors in the affected patch. This seems to establish the fact that frost plays no part in the development of double blossom of the berry canes.

THE RELATION OF SCALE-BUDS TO DOUBLE BLOSSOMS.

Another theory advanced was that the scale-buds did not have time to mature and properly develop perfect flower buds: hence their sterility; and that the witches broom is an abnormal growth resulting from the forcing immature scale-buds.

To investigate this theory we selected on October 4, 1909, two lots of buds. One lot, consisting of 351 buds, was treated by removing only the apical portion of the primary bud, thus leaving the secondary and scale buds unharmed. Of these 351 buds 119 developed shoots and only 21 developed fruit. Of these 21 shoots 15 developed from secondary and 6 from scale-buds.

The results seem to indicate that shoots arising from secondary and scale-buds, when flowers are produced, will, all other conditions being favorable, develop well formed fruit.

The number of branches to the brooms ranged from 1 to 3. Of the 119 growing buds 97 produced one branch, 14 produced two branches, and 8 three branches.

In most of the cases the secondary only developed in place of the primary bud. Sometimes the secondary and one or two scale-buds de-

veloped. While most of the shoots were flowerless like those of the witches broom, yet not one developed any abnormal flower.

Since in the treatment outlined above the secondary bud usually takes the place of the injured primary, and since the secondary bud is better developed than any scale-bud, a second lot consisting of 267 buds was selected on the same date, in which the apical portion of both the primary and the secondary buds was removed. This operation throws all the growth into the production of adventitious branches.

The results of this work are as follows: Of the 267 buds that were treated only 43 put forth branches. Of these 33 produced one branch, 7 two, 2 three, and 1 four branches.

FIG. 3.—Lucretia dewberry canes showing affected flowers and bud on the right, and a normal flower and bud on the left.

Of the 43 branches that leafed out only three bore fruit, each bearing one berry to the cluster; three had normal flowers, and the rest produced only sterile branches.

The size of the brooms was, as noted above, from one to four branches —not at all characteristic of the double blossom.

RELATION OF APHIDS TO DOUBLE BLOSSOM.

It was noticed that whenever a sufficient number of aphids attack the young growth of blackberries an abnormal swelling of the cane results. An equally deformed fruit panicle may result whenever the attack is directed to a leaf bud.

To determine their influence three canes that were covered with green aphids and were already deformed on the extremities were transferred from the field to the greenhouse.

These canes developed normal leaves and branches, with the exception of one, which produced a witches broom. This broom, however, was not the result of the work of aphids, but as will be seen later, the natural outcome of having stood in the field in too close proximity with diseased canes.

The fact that the other two canes did not produce any apparent symptoms of the disease is good evidence that aphids do not cause the double blossom of the berry canes.

Pathological Investigation.

All the above work has given us only negative evidence on the disease question and brought us little or no nearer to the solution of the problem. Therefore, the pathological side of the question contained the only possible solution to the problem within the scope of the investigation.

Looking at the problem from this view point the work naturally falls into four lines of procedure.

1. To determine whether the double blossom is infectious.
2. The finding of the parasitic organism and its isolation in pure culture.
3. Inoculation of plants and production of the characteristic symptoms of the disease.
4. The re-isolation of the organism from the artificially inoculated plants.

To determine whether the double blossom is infectious and whether the disease spreads from the old to the young canes three blackberry (*R. nigrobaccus*) and six dewberry plants (*R. villosus*) were grown from root cuttings of wild plants.

On March 14, 1910, two of these blackberry plants and four dewberry plants were set, without removing the flower pots, among diseased canes of wild blackberries. Here the plants were left for the remainder of the summer.

The remaining blackberry plant and the two dewberry plants were set out as check plants, not among diseased but among healthy canes, and left there for the remainder of the year.

On February 2, 1911, all plants were gathered up and set in the greenhouse for developments.

The two blackberry plants that had been standing among diseased canes showed, on March 17, one diseased leaf bud on one plant and two on the other.

Of the four dewberry plants similarly treated one died before putting forth its leaves, two produced one broom apiece, and the fourth produced eleven distinguishable witches brooms.

The check plants, both blackberries and dewberries, are perfectly healthy and show no symptoms of disease.

This is strong evidence that the disease commonly known as double

blossom is transmitted from the old to the young canes. Our second step was to find in the diseased buds a parasitic organism that can be isolated in pure culture.

Numerous buds of apparently healthy canes that stood in the diseased clumps were examined under the microscope. A fungus was detected, isolated, and grown in pure culture.

FIG. 4.—Witches broom and empty calyses of Wilson blackberry flowers.

The media used, on which to grow the fungus, were ten per cent and thirty per cent saccharose solutions, blackberry leaves, and blackberry leaf agar.

The vegetable growth was most luxuriant in the saccharose solutions and on the agar, and the least on the blackberry leaves, however, the fungus produced spores earlier on the leaves, while in the solutions and on the agar little or no spore production was observed.

The next step was to make inoculations on blackberries and dewberries that would cause the disease.

Root cuttings of the wild high bush blackberry (*R. nigrobaccus*) were made from which to grow perfectly healthy plants. Also tip layers of the Lucretia dewberry were selected and all transferred in January, 1910, to the greenhouse, so as to avoid possible infection by wind and insects.

In all 25 dewberry plants were selected for the test, 23 for inoculation and two for check plants. Of the blackberry plants 35 were selected for the experiment, 32 for the inoculation and 3 for check plants.

On February 19, 1910, when the plantlets had attained a height of six inches, the first inoculations were made, both on blackberries and dewberries. These were made by dropping onto the axillary leaf-buds a suspension of spores of the fungus in tap water. Similar inoculations were made on February 28, March 4, 11, 16, 23, and 27.

Fig. 5.—Spores of Fusarium, rubi, Winter.

On March 28 dry spores and mycelium were introduced into all of the available leaf buds of the plants with the aid of the blunt point of a needle.

On April 2 and 7 a suspension of spores was again dropped onto all available buds of both lots of plants. On April 13 the larger buds were again pricked with a blunt needle, but instead of dry spores being introduced a suspension of spores was simply dropped onto all injured buds.

On April 20 and 29, on May 7, 14, 20, and 28, and also on June 11 and 23, spores in suspension were dropped over the uninjured and previously injured buds.

On June 29, July 5 and 28, and August 5, small colonies grown in saccharose solutions and fragments of mycelium of the fungus suspended in water were dropped onto the later formed leaf buds.

The two dewberry plants and the three blackberry plants reserved as check plants were kept in another part of the greenhouse, so as not to become infected from the liberated spores.

The inoculated plants were kept in a cool room of the house and by November 30 they had grown to a length of 18 feet.

On January 3, 1911, the bottom leaf buds on the canes of both dewberries and blackberries began to swell. These later on proved to be typical cases of the double blossom.

The check plants did not begin growth until about February 11, 1911, and on March 21 they did not show a sign of the double blossom disease, although the infected flower buds on the inoculated canes were blooming profusely.

Of the 23 inoculated dewberry plants 22 produced witches brooms and only one did not develop the disease.

On March 17, 1911, these 23 dewberry canes showed a total of 90 witches brooms. The check plants produced no brooms and developed no symptoms of the disease.

Of the 32 inoculated blackberry canes 16 died down to the ground after the spore inoculation, but new canes sprung forth before the treatment with the mycelium. These 16 new canes produced only one witches broom.

The other 16 plants did not put forth any new growth, but have remained alive up to the present writing. Of this lot 11 out of 16 plants showed the diseased buds and five had no apparent symptoms.

These 11 affected canes showed on March 17, 1911, a total of 78 characteristic witches brooms.

On November 15 and December 5, 1910; also on January 30, 1911, a total of 157 dewberry buds and 139 blackberry buds were inoculated with mycelium from the saccharose solutions and the blackberry agar.

Of the 157 dewberry buds only seven showed the symptoms of the disease and the balance remained apparently unaffected.

Of the 139 blackberry buds only one showed the diseased condition and the balance were apparently healthy.

Evidently this last inoculated lot of buds was too far advanced for the fungus to get a secure foothold.

Fearing that the greenhouse conditions were not suitable for the development of the fungus, inoculations were made out of doors on April 30, 1910.

The spot selected is in a little grove of mixed deciduous trees. No traces of the witches brooms were to be found in the vicinity and the blackberry canes growing there were all vigorous.

On April 30, 1910, healthy canes were selected out of the midst of a clump for the purpose of inoculation. Spores were used to tranfer the fungus and each inoculated cane was carefully marked.

All of the adjacent canes were left as a check.

On March 17, 1911, observations showed that three of the ten canes had died during the winter, but the remaining seven were covered with miniature rosettes—79 in all.

The adjacent canes were carefully examined and buds were dissected under the microscope, but no trace of the fungus could be found.

The experiment corroborated the results that were obtained in the greenhouse.

In order to determine whether the witches brooms that were produced in these experiments were caused by the same parasitic fungus obtained from field specimens, the work of re-isolating the organism from the artificially produced witches brooms was begun. The fungus was easily extracted from the diseased buds and isolated in pure culture. This newly isolated fungus corresponds in all particulars with the original. It shows the same fish-net like growth of the mycelium in the leaf buds; the same peculiar crystals of salt that are always associated with the mycelium in the bud; the same method of spore production; the same shape, size, and hyaline color of the spores; the same greenish by-product when grown on artificial cultural media.

In every respect, so far as can be determined, this fungus is identical with the one always found in the diseased buds in the field.

SYMPTOMS OF THE DISEASE.

The double blossom disease is caused by a parasitic fungus that lives first in the leaf buds of the young canes, and as they develop it spreads over the entire resulting rosette. The worst damage results from the infestation of the floral organs, which means death to the embryonic berry.

In the early part of November the mycelium can be detected with the aid of a microscope in the affected buds of young canes. Upon dissection of the buds in January it comes out in flake-like particles, and these under the microscope have the appearance of torn and imperfect fish-nets. All through the winter months the fungus continues to develop inside of the bud until by the end of February all of the interstices between the embryonic leaves are completely filled.

As a rule on the outside of the bud no visible change occurs until the appearance of the warm days of spring, when the most affected buds begin to swell prematurely and push forth their leaves. These usually have a reddish color, which can be seen at some distance.

Instead of one normal shoot growing from the bud a great indefinite number may appear, which cluster, later, at maturity, is spoken of as the "witches broom."

When the buds are only partly affected so that the flower buds alone suffer, then these symptoms can not be detected by the naked eye, and later developments alone will manifest the disease.

If the infested leaf buds can be distinguished in the fall of the first year then the cutting out of the affected canes can be accomplished early, and thus curb the spread of the epidemic.

To determine whether this diagnosis can be made in the fall of the year, 160 lateral leaf buds that looked suspicious were labelled in 1909 and their development noted in the following season.

Observations showed that of the 160 buds so labelled not one developed the witches broom. However, it was noticed later that some of the very earliest and worst affected leaf buds do prematurely push forth a miniature broom in the fall of the first year, but these are only a very small percentage of the total number of buds so affected.

Instead of killing the young leaf bud from the start the fungus stimulates it to more vigorous growth, increasing thereby its food supply and causing the familiar cluster of branches commonly known as the witches broom.

These brooms may be large or small, depending upon the size and vigor of the parent plant. It is a peculiar but well-known fact that these brooms are formed primarily by the development of basal or scale-buds of the new shoot or shoots. Most of these resulting branches are sterile and will not put forth any flower buds. The normal fruit panicle, after having spent all of its energy in the production of woody and leaf tissue in the broom formation, is materially reduced in size and number of fruit buds. The flowers that develop both from the branches and from the terminal panicle of the broom are usually so infested with the fungus, and the floral organs are so distorted that no fruit development could possibly ensue.

TREATMENT OF THE DISEASE.

Our spraying experiments have not been conducted long enough to give conclusive results as to whether spraying will be practical in the treatment of this disease. The results so far indicate that spraying will not prove a practical remedy.

The best treatment that we can recommend for this disease in this State at the present time is to cut off all the dewberry canes (both young and old) at the surface of the ground as soon as the picking season is over. The canes should then be removed from the patch and burned. This treatment removes all the old diseased canes and any young canes that have become infected early in the season. Where this treatment is given every year the disease is kept under absolute control.

The treatment outlined above is now being given by nearly all of the growers in this State to control anthracnose and leaf spot. Hence the one treatment will control the three most serious diseases of the dewberry.

The varieties of blackberries most seriously affected by double blossom are now seldom planted in this State. We now have varieties of blackberries that so far have proved resistant to this disease which ought to replace the affected varieties entirely. Where the affected varieties are grown the best remedy will probably be to destroy the affected parts early in the spring before the blooming season.

PRELIMINARY REPORT OF INVESTIGATIONS WITH THE CORN BILL BUG.

Particularly with *Sphenophorus callosus.*

By R. I. Smith, Entomologist.

The corn bill bug, *Sphenophorus callosus,* was reported as doing unusual damage in the spring of 1910, in Camden and other of the coastal counties. This damage was reported to Director Williams with a request that the Station commence an investigation of this pest, which, the corn growers stated, was increasing in alarming numbers. To prepare for complying with this demand your Entomologist made a trip to Columbus and Robeson counties, where he found some very serious bill bug injury. On June 20, 1910, at Braswell, Columbus County, on a

Fig. 6.—*S. callosus.* Adult Beetle stage of Corn Bill Bug: On left and middle, males, photograph of dead specimens; on right, live female standing on glass, in natural position, ready to walk. (Original.)

farm owned by F. T. Shepherd, a corn field was discovered at a time when the third planting of corn was being destroyed by the bill bugs, even though the latter were comparatively scarce, because of hundreds having been collected by hand during the previous two or three weeks. On this same trip bill bugs were discovered and collected at Chadbourn (in a rice field principally), and at three points in Robeson County, namely, Lumberton, Proctorville, and Elrod. At all these places the bill bugs were found to be laying eggs and breeding in the corn plats, a condition that was not previously known to exist in this State. Practically all previous reports state that the bill bugs breed entirely in rice and sedge grasses, but not in corn.

The bill bugs collected on this trip, from the points mentioned, were taken to West Raleigh and kept alive on green corn stalks in which they

continued to lay eggs until after September 3, and probably later, but after that date they were given no further careful attention, except to be given occasional fresh food. Of this lot of beetles collected June 20, 1910, originally 17 in number, 16 were found alive on February 14, 1911, but on March 1 all were dead. During the winter the beetles were kept in a large glass jar half full of earth, in which they remained buried, except on warm days, when two or three were sometimes seen moving about on the surface. If these beetles had not been disturbed, as was necessary to determine their condition, some would doubtless have lived longer. This represents the first of the bill bug investigation.

On August 27, 1910, an outline of a proposed investigation of the injurious species of *Sphenophorus* occurring in North Carolina, but especially the principal injurious species, *Sphenophorus callosus,* was submitted and accepted as an Adams Fund project.

The preliminary report herewith given, records the general observations and study which was desirable before commencing a careful life history investigation of these insects, such as is now under way. The investigation will doubtless cover two or three years, as the writer can not take up all phases of the study in one season without assistance.

During the trip to Robeson and Columbus counties, about June 20, 1910, the young stages, that is, eggs, larvæ, and pupæ, were secured, and enough information obtained to enable the writer to search intelligently for this pest in other places. This resulted in his finding *Sphenophorus callosus* breeding in certain species of *Cyperus* grasses growing in corn fields at West Raleigh, and, later, in finding out other food plants, which are recorded below.

On July 28, 1910, bill bug eggs and larvæ were discovered in the stems and roots of Elegant Nutgrass, *Cyperus flavicomus,* in bottom land at West Raleigh. A few eggs, but no larvæ, were found in some young corn plants. During August and September many *Sphenophorus* larvæ, pupæ, and adults were collected from *Cyperus flavicomus* growing in corn fields about West Raleigh, all the specimens proving to be *S. callosus.*

On October 5-7, 1910, a trip was made to Lumberton, Chadbourn, Proctorville, and Pembroke, to collect bill bugs to keep during the winter for life history work this spring. It proved impossible to find more than one or two beetles in the corn fields where the eggs and larvæ were found in abundance during the June trip, but a rice field at Pembroke and another at Chadbourn yielded a number of beetles which were taken into the laboratory and kept in jars of earth during the winter. Pupæ, from which adult beetles were reared, were also taken on this trip. New food plants were also discovered.

FOOD PLANTS.

The food plants thus far determined are listed herewith. Eggs, larvæ, and in some instances pupæ, of *S. callosus,* have been taken from the roots, or beneath the roots, of the following plants. Breeding in corn

at Braswell, Elrod, Chadbourn, Proctorville, St. Paul's, Pembroke, and Raleigh, June to October, 1910.

Breeding in *Cyperus flavicomus*, July and August, 1910, at Raleigh.
Breeding in *Cyperus strigosus*, October 4, 1910, at Lumberton.
Breeding in *Cyperus strigosus*, October 6, 1910, at Chadbourn.
Breeding in *Cyperus cylindricus*, October 4, 1910, at Proctorville.
Breeding in *Cyperus overlaris*, October 7, 1910, at Pembroke.
Breeding in Rice, October 5-7, 1910, at Chadbourn and Pembroke.
Breeding in *Cyperus esculentus*, June, July, 1911, at Raleigh.

It is probable that many other *Cyperus* grasses and probably some other closely related grasses will prove to be food plants.

WINTER STAGE.

Judging from the actions of the beetles confined during the past winter months in glass jars on several inches of earth, it seems that they normally lie buried from one to three or four inches deep, but sometimes become active during warm spells. This seems all the more certain because the writer has spent many hours searching for bill bugs this past winter, but has never found any of them under weeds, trash or materials where they would hide if they remained above ground.

On March 28, 1911, the writer went to Chadbourn, Columbus County, for the express purpose of trying to find corn bill bugs. A visit was made to a rice field where the insects were breeding freely last year, and several hours were spent in hunting for the bill bugs, in all possible situations. Everything under which they could hide, weeds, bush, stones, etc., were examined, but no beetles were found. After some two hours' search one bill bug was discovered in the dead grass on a mound of earth around a stump in the edge of the rice field. This beetle was alive and active, evidently having emerged from its winter shelter. Much rice stubble was also dug up and the roots searched for bill bugs, but with no success. A nutgrass field, *Cyperus strigosus,* near by, where bill bugs were breeding freely last October, was next examined, but no sign of the bill bugs, except evidence of their work in the roots, could be found. This search indicated that the beetles must be buried in the soil, unless they had deserted the field for parts unknown.

On March 30, at Braswell, a whole day was spent searching for bill bugs, but with no success. This was the place where corn of the third planting was destroyed in June, 1910.

On March 31 a rice field at Pembroke was visited and several hours were spent looking for bill bugs, both above and below ground. Not a single specimen was seen.

During the month of April last, several field trips were made around Raleigh, searching for bill bugs in places where they were breeding in *Cyperus* grasses last fall. The beetles were searched for in all manner of situations, under all kinds of protection, and in the soil under some dead *Cyperus* plants which were discovered. Several plants in which the *Sphenophorus* larvæ had fed, were discovered, but there was no sign of the insects.

The beetles that were kept all winter in jars of earth were examined at different dates, and, as already stated, one or two were seen moving about on warm days. The majority remained buried all the winter.

On April 13, when it seemed that some beetles should be emerging from winter quarters, two lots of beetles were taken into the laboratory from the outdoor cage, where they had been kept, and each lot examined.

Lot 1 contained 10 beetles that were bred from pupæ collected from *Cyperus flavicomus* near Raleigh, during September, 1910. Two dead beetles were found on top of the soil, the remaining eight were located in the soil at depths of one to two inches. Six of them, when dug out, were active; two were alive, but would not crawl about.

Lot 2 contained 20 beetles collected in the adult stage from beneath roots of *Cyperus flavicomus* about September 10, 1910. Of this lot nearly all were buried from one to three inches deep. Upon digging them all out on April 13, 17 were found alive; the other three were dead.

These two lots of beetles were placed back on loose earth and given young green corn plants for food. The notes recorded show that all but two or three of each lot immediately buried themselves in the soil and were not again disturbed until after April 26. The beetles of Lot 1 did not feed, but one or two of the beetles in Lot 2 fed a little every day after April 13. Evidently the majority remained buried.

Lot 3, consisting originally of 29 beetles, collected October 5-7, 1910, from fields at Braswell, Chadbourn, and Pembroke, were not disturbed after they buried themselves for the winter, until May 1, 1911. On that date the large tin can of earth in which they had passed the winter was taken into the laboratory and examined. The warm weather had brought 12 of these beetles to the surface, where some were moving about; the remainder were buried in the usual manner. Of the entire number 26 were found alive. These were placed in a glass jar with pieces of moist blotting paper and given fresh corn plants for food. On May 2 some had fed considerably, but none of them showed signs of mating.

FIRST BILL BUGS DISCOVERED IN FIELD.

On April 19 and 20, several hours each day were spent looking for bill bugs in fields near West Raleigh where *Cyperus* grasses grew last fall, and in fields where corn was just coming up. All possible hibernating quarters were also examined, but not a single bill bug discovered.

On May 2 another search was made with better success. After three hours search one beetle was taken on a young corn plant in an upland field in which considerably so-called nutgrass was springing up. This beetle proved to be *Sphenophorus venatus*. Unfortunately it lived only a few days.

In the field where this beetle was found the corn was only a few inches high, but several plants showed the characteristic holes, made by bill bug bites before the tender leaves were unfolded, showing that this specimen, and others, no doubt, had been feeding several days. Search was made for eggs, but none were found.

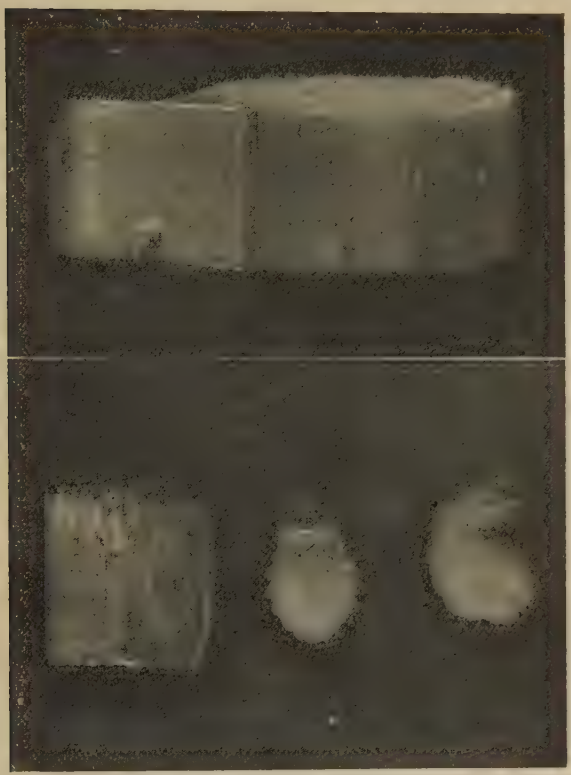

FIG. 7.—*S. callosus.* Corn Bill Bug Eggs and Larvæ: Upper figure shows short section of corn stalk as supplied beetles for food to secure daily egg-laying record; egg embedded in natural position in the tissue on inner side of the outer leaf. Lower figures show egg fully exposed; larvæ about two-thirds grown, ventral and side views. All enlarged 2½ times. (Original.)

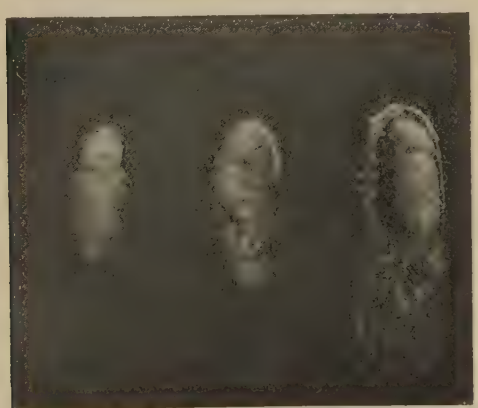

FIG. 8.—*S. callosus.* Pupæ and Cocoon Formed of Corn Fiber: Two small pupæ on left, upper and side views; on right, live pupa in its cocoon. (See Fig. 11, showing how this cocoon protected the pupæ.) All enlarged 2 times. (Original.)

On May 9 the writer was at St. Pauls, in Robeson County, and discovered bill bugs, *Sphenophorus callosus,* in a corn field belonging to Mr. Marcus Smith. The corn had been replanted, and, according to Mr. Smith, most of the first planting had been killed by the bill bugs. About 75 per cent of the second planting was damaged. Bill bugs were not easily found, but after a search of one and one-half hours 15 beetles were collected. No sign of eggs could be found. These beetles were taken to the laboratory and fed on young corn plants and watched daily for signs of mating and egg-laying, but this was not noticed until after May 22, when another lot of beetles commenced to lay eggs.

On May 22 eggs were secured from a lot of over-wintered beetles collected at Braswell and Pembroke in October, 1910. As this date came on Monday and the specimens were not examined on Sunday, it may be that the eggs were laid as early as Saturday afternoon, May 20.

Previous to this date, that is on May 13, three bill bugs were taken in a field near Raleigh, but they died in a few days. No eggs were found on that date. On May 19 one female *Sphenophorus parvulus* was found on yellow nutgrass, *C. esculentus,* and as this beetle proved to be fertilized it has since been kept for a daily egg-laying record.

EARLIEST RECORD OF EGGS IN FIELD.

After finding eggs on May 22, laid by the beetles in confinement, the writer went at once to the corn-field where a bill bug had been collected May 2. This trip proved fruitful. Eggs were discovered in the so-called nutgrass, since identified as *Cyperus esculentus,* and considerable evidence of bill bug feeding was observed on both young corn and nutgrass plants.

That this date represents about the earliest for egg-laying in the field is evidenced by a letter from Mr. Marcus Smith, of St. Paul's, dated May 26, who stated that "beetles have commenced to lay eggs." (Mr. Smith had been on the outlook for egg-laying at my request.) As further evidence a letter from Mr. F. T. Shepherd, of Braswell, dated May 17, states that "bill bugs have not commenced to lay eggs."

EGG-LAYING RECORD COMMENCED.

After May 22 individual pairs of bill bugs were taken as rapidly as possible from the material on hand, and each pair isolated, with corn for food, in a jelly glass, to secure daily egg-laying records. On May 26 a batch of bill bugs, about 190 in number, were received from St. Paul's through the kindness of Mr. Marcus Smith, and from this lot most of the pairs for egg-laying were secured. For some reason not yet understood the beetles kept in confinement during the winter did not seem to lay eggs freely. Some of the pairs secured from that material failed to lay any eggs, while others laid only a few. At the same time some of the females secured from St. Paul's refused to lay. Several pairs were kept and fed for 30 days, from May 22 to 28 until July 5, and no eggs were secured. Others, kept for the same length of time, laid an occasional egg at long intervals. Complete records are on hand to be used for a full report of this work.

Over 50 mated pairs of bill bugs were taken, but at this date, July 1, only 24 pairs are being kept for a complete egg-laying record. From some of these pairs over 150 eggs have been secured since May 28, an average of about five eggs a day. The eggs were counted and fresh food given the beetles each day. The large number of pairs retained for a complete egg-laying record will serve to furnish a good average record of egg-laying.

FIG. 9.—*S. Callosus.* Corn Bill Bug Larva in Feeding Cavity in Corn Root. Larva reared from egg, twenty-eight days old, but small for age. Enlarged 2 times. (Original.)

EGG-HATCHING RECORDS.

From the eggs secured, hundreds of hatching records have already been obtained, showing an incubation period of from about five to ten or eleven days, dependent on both moisture and temperature conditions.

FEEDING AND EGG-LAYING HABITS.

An accurate knowledge of the habits of the bill bugs as regards feeding and egg-laying is being learned by daily observations. The behavior

FIG. 10.—*S. callosus*. Corn Bill Bug Larvæ in Crown of Red Rooted Cyperus Grass (*C. flavicomus*). Collected from a corn field, September 9, 1910. Larvæ about full grown, one-half natural size. (Original.)

of the confined beetles seems to be, in every respect, similar to that observed in the field.

LIFE HISTORY STUDIES.

The work now in progress promises to result in an extensive number of records of the complete life cycle of individuals from egg to adult stage. Already several dozen larvæ have been carried to near maturity

FIG. 11.—*S. callosus*. Cocoons Formed of Corn Fiber for Protection of Pupa. Empty cocoon on left was formed in the soil just beneath corn stalk in which the larva completed its growth. Cocoon shown in corn stalk was photographed in natural position at lower end of feeding cavity. See Fig. 8, showing the other side of this cocoon and the live pupa.
(Original.)

and some will pupate within a few days. The eggs are hatched either in glass vials or tin boxes and the larva as secured are placed carefully in a hole cut into a young corn root. In this manner the larva are given food almost exactly similar to what they get in the field, and it has not been found difficult to get them to feed and grow rapidly, even though partly disturbed each day for the purpose of determining the number of molts and their rate of development.

This work is requiring constant attention and careful manipulation, but the results are promising.

Larvæ of all ages, and in all stages of development are being preserved for measurement and microscopic examination when time permits.

Fig. 12.—Outdoor Laboratory for Studying Life History of Insects. This structure is built with light wooden frame, covered with ordinary 12-mesh wire screen.

All the above statement refers to *Sphenophorus callosus*, unless otherwise stated. This species is the one that causes all the damage reported from the eastern counties. So far as the writer knows this species has never been recorded as feeding on corn in the vicinity of Raleigh. The observations made this spring seem to indicate that, while the species is quite numerous here, and breeds freely in yellow nutgrass, *Cyperus esculentus*, in the early summer and, later, in Elegant Nutgrass, *Cyperus flavicomus*, also, it does not naturally cause much damage to the young corn. During the last two months the field observations have shown that young corn is often attacked, but no real injury, except for a few plants, has been observed. To one familiar with bill bug work it is easy to tell where the bill bugs have fed, even after the corn is nearly grown. The characteristic holes made by the bill bugs when the corn leaves are

tightly rolled together and show prominently when the leaves expand, are certain evidence of bill bug work.

BILL BUG STUDIES CONDUCTED OUT DOORS.

All the life-history studies of bill bugs, egg-laying, egg-hatching, rearing larvæ, etc., have been conducted in a wire screened cage where the temperature and moisture conditions correspond almost precisely with field conditions. This outdoor laboratory is situated so as to get full exposure to light and air, and, except for having a roof to protect the material from storms, it is subject to all changes of weather. This has made it possible to conduct the work in such a manner that the results correspond closely with field conditions. The writer has carefully watched the development of bill bug eggs and larvæ in the field and finds that his cage experiments are practically identical with field conditions. In the end this will make the results of special value.

SPHENOPHORUS PARVULUS.

This small species of *Sphenophorus,* of which one female was collected on May 19, 1911, is not common here, but the writer has commenced a life history study of the species. Thus far no other specimens of this species have been taken here or elsewhere. Fertile eggs have been secured and the larvæ obtained are being reared in the same manner as the common species, *S. callosus.* The single female under observation has laid 63 eggs, commencing with three eggs on May 22; on June 30 three eggs were laid and the beetle shows no sign of stopping. The newly-hatched larvæ are very small and require very careful handling. The first larva was secured June 8, and since then several have hatched and are now feeding and growing satisfactorily.

A TROUBLESOME MITE.

Within the last few days a mite, *Tyroglyphus americanus,* Bks., has appeared in the experimental cage. This mite is a common laboratory pest in the Eastern States and as it often attaches itself to adult insects it is carried into the most unexpected places. It probably came to the cage on some material collected in the field. Just how troublesome this mite will prove to be is hard to tell, but when it appears in a section of corn stalk in which a young *Sphenophorus* larva is living it becomes necessary to remove the larva to fresh food, thus requiring much extra work, besides making it difficult for the larva to develop naturally. A small weak larva is usually killed and devoured by these mites, but the larger larvæ are often able to protect themselves.

THE HOUSEFLY (*Musca domestica*).

Breeding Places of Houseflies; Cow Manure Proven to be Important Source; Successful Use of Formalin in Milk as a Fly Poison.

By R. I. Smith, Entomologist.

This report covers work done by the writer during June and July 1911, while attempting to reduce the housefly nuisance around the A. and M. College dairy and horse barns, and in the West Raleigh section. Although no systematic experiments were planned more work was done than was at first anticipated, and the information and results obtained were of such a nature as to make it seem advisable to furnish this report. One principal result of this work was in determining that flies breed in large numbers in the cow manure from the dairy barns, and in the calf stalls, wherever a large number of animals are kept, as well as in the horse stables, whence most of the houseflies have been supposed to originate. Another important feature of the work was the demonstration of a successful method of using 40 per cent formalin with sweet milk as a fly poison. By combining the two methods of preventing the breeding of flies by weekly removal of all stable manure, and by poisoning great numbers of flies with formalin mixture, the fly nuisance at the A. and M. dairy barns was reduced to a minimum, so much so that during July the flies were reduced to much less than one-tenth their usual number. The formalin method of poisoning flies was taken up by the citizens of Raleigh and vicinity and in other towns throughout the State as a result of newspaper articles furnished the local daily papers. It has been learned that fly screens have been placed in many houses which have never before been screened. Even the Raleigh City Market was thoroughly screened after this warfare on the housefly was inaugurated. Formalin-milk poison was used successfully in the city market after the place was first screened. The local druggists sold many gallons of formalin within a few days after the success of this treatment was made known through the Raleigh papers.

Press Bulletin No. 23, entitled "How to Suppress Houseflies," was written and published under date of June 20, and mailed to all the newspapers of the State. This Bulletin, in addition to the articles which the writer prepared for the local daily papers, aroused considerable interest in the housefly situation. It should be stated here that additional interest was created by two articles prepared by Dr. F. L. Stevens, Bacteriologist, concerning the ability of houseflies to carry disease germs, thus emphasizing the danger of houseflies as a conveyor of typhoid fever and other intestinal diseases. These articles appeared in Sunday editions of the Raleigh *News and Observer*.

The actual observations and work recorded herewith had to be conducted at irregular intervals as the writer's time was principally needed for an investigation of the corn bill bug. For this reason no excuse is offered for the apparent incompleteness of some of the experiments and observations recorded.

During the latter part of May, 1911, the houseflies became unusually numerous and troublesome in the West Raleigh section, and the same condition was true in the city of Raleigh. A few cases of typhoid fever about this time served to emphasize the necessity for some attempt to suppress the flies. On May 22, 1911, Director Williams sent a circular letter to the residents of West Raleigh, in which the A. and M. College is located, asking for some coöperative attempt to reduce the houseflies. The writer was requested to determine where most of the flies were breeding, and to make such experiments as seemed advisable to destroy them, both by attacking the larvæ and pupæ in their breeding places, and by poisoning or trapping the adult flies.

FIG. 13.—The Old Method of Housing Stock. Houseflies breed by the thousands in the manure that is usually allowed to accumulate for weeks or months.

BREEDING PLACES.

Stable manure of all kinds was found to be literally swarming with maggots, of which a large per cent proved to represent the true housefly. The horse and mule stables were first investigated, and in every one, where the manure had not been removed within the previous two weeks, the maggots were present in great numbers, while the presence of many empty pupal cases showed conclusively that adult flies were emerging every day. This of course was to be expected, as horse manure is recognized as a common breeding material.

HOUSEFLIES BRED FROM COW MANURE.

The cow manure accumulated around the dairy barns and calf stalls was next examined. In it the maggots were present in enormous numbers, and on several occasions bunches of both recently formed pupæ and

empty pupal cases, were discovered. It was very apparent that the maggots which swarmed through the manure were inclined to congregate in certain corners or crevices and pupate in a mass, often nearly as large as one's fist, such masses sometimes containing over a thousand pupæ. smaller masses of pupæ and empty cases from which the flies had emerged, were also found. Scattered pupæ were discovered around the edges of the piles of cow manure and even in the soil underneath where the maggots had burrowed before pupating. These last observations are important for they may explain in some measure the reason why many writers have stated that cow manure is not an important source of house-flies.

About July 10 a number of pupæ were collected from underneath a pile of cow manure, which was almost pure except for a little straw and ensilage used for an absorbent. From this lot 76 flies emerged and all but one proved to be the true housefly. The other one was the biting stable fly, *Stomoxys calcitrans*. Those flies were sent to Washington and identified by Dr. L. O. Howard of the Bureau of Entomology. Dr. Howard stated in his letter, "they are undoubtedly the housefly," but commented further: "The fact that the cow manure was mixed with straw and ensilage accounts for the houseflies being able to breed to such an extent." In the writer's opinion this simply emphasizes the danger of cow manure being a source of flies, for in this State nearly everyone uses considerable absorbent in the cow stalls and calf pens.

OTHER SOURCES OF FLIES.

Aside from the flies emerging from all kinds of stable manure, perhaps the most dangerous source is the open privy, as the flies emerging from such situations are more liable to convey the germs of typhoid fever and other diseases. Any accumulation of decaying vegetable matter, neglected garbage cans, etc., may serve to breed flies. One loathsome condition that came to the writer's attention was that of finding maggots in the dirty linen from a restaurant when received by the laundry to which it was sent.

Without going into further detail it may be stated emphatically that the principal source of house flies is from stable manure, but there are always minor sources that can readily be removed when the residents of any vicinity commence an active campaign.

ATTEMPTS TO KILL HOUSEFLY MAGGOTS IN MANURE.

Kerosene.—The liberal use of kerosene on horse manure has been tested at Washington, D. C., with rather unsatisfactory results. Although aware of this fact the writer made one test with kerosene on cow manure in which the maggots were swarming. Two gallons of kerosene were sprayed over about 25 square feet of a manure pile. It was found that this quantity did not soak in over about one inch deep, and only a very few maggots were killed. It seemed that the maggots near the surface simply worked down out of reach of the kerosene, for otherwise they could not have survived the treatment. On the day following there was practically no indication that the kerosene had had any beneficial effect.

After 24 hours it was so nearly all evaporated that the odor was not strong and the adult flies were hovering over the pile in their usual numbers.

Acid Phosphate Mixed With Cow Manure.—To determine the chance of improving the fertilizer value of cow manure and at the same time prevent the housefly maggots from developing in it, 16 per cent acid phosphate was tested by mixing 200 pounds with about 2,000 pounds of manure. The test was commenced by taking all of one day's accumulation of manure from the dairy barn, amounting to about 200 pounds, and mixing in 20 pounds of acid phosphate. The manure was piled in a smooth place out doors. Three days later the same amount was taken

FIG. 14.—The Modern Method of Handling Stable Manure. Houseflies prevented from breeding by removing the manure from the stable every day and hauling the pile away at least once a week.

and mixed in the same manner and piled on top of the first; the sixth day's manure was similarly treated and thrown on the heap. This pile was kept for two weeks and frequently examined. For comparison, an untreated pile of manure from the same source was kept beside the treated pile. This experiment proved entirely worthless from the standpoint of killing the maggots, as they were present by the thousands in both piles when the experiment was discontinued.

The manure treated with acid phosphate contained as many maggots as the untreated pile. Both piles were kept until some pupæ were formed, showing that the maggots had commenced to mature.

A second test with acid phosphate was afterward made, using 400 pounds to about 2,000 pounds of cow manure, but the result was the same as when only 200 pounds were used.

Floats.—An experiment was made to determine the value of floats (finely ground phosphate rock), mixing 400 pounds with about 2,000

pounds of cow manure. The experiment was conducted in the same manner as that just recorded for acid phosphate, and the result was the same.

Formalin Solution (4 per cent).—After formalin solution for poisoning adult flies had been successfully used, as recorded below, the writer was asked to try a 4 per cent water solution of formalin on a pile of manure. This experiment was made about the middle of June. A pile of cow manure literally swarming with maggots was selected and sufficient liquid applied to soak in around the maggots. In fact, care was taken to actually saturate certain spots where the maggots were most numerous. This treatment proved practically worthless; possibly a few maggots were killed, but examination of the manure did not show it.

Disinfectant Sprays in Box Stalls.—The liberal use of disinfectants, such as Creolin, Zenoleum, etc., applied three or four times a week to the walls and floor of box stalls serves to keep flies out to some extent, but the writer's observations lead him to believe that such applications are of comparatively little value as usually used. Some disinfectants have been used in box stalls at the College barn, but never with great success. The amount of disinfectant necessary to actually keep the flies from entering and depositing eggs, renders the treatment too costly and troublesome. A disinfectant lightly sprayed over the manure has no effect whatever on the maggots which are already present.

All the work conducted shows that the weekly removal of all stable manure, and that accumulating in the yards or piled outside, is the only way to really prevent flies from breeding around the barns. When this method is properly carried out formalin poison may be used to eradicate many of the flies. As already stated it was by this combination of removing the breeding material and killing adult flies that the flies at the A. and M. College barn and dairy were so effectively controlled during June and July.

FORMALIN-MILK MIXTURE SUCCESSFULLY USED AS A FLY POISON.

Early in June, 1911, experiments were commenced with a commercial grade of 40 per cent Formalin for poisoning the houseflies around a dairy barn and milk room, where they were extremely numerous. Previous to that time the flies had been increasing rapidly in the horse stables, calf stables, and around the dairy barn, from which places the manure had not been removed for several weeks. The conditions, therefore, were ideal for a conclusive test of the formalin as a poison. Furthermore, in this situation the flies had abundant material for food, in the milk room where the milk was strained twice a day and in the stables and stock yards. Plenty of water was always present, a thing on which flies are very dependent. Under these conditions it would not have been surprising if the flies had refused to feed on the formalin-milk mixture, but fortunately the experiments were successful.

FORMALIN-MILK MIXTURE.

Formalin has been used more or less for several years as a fly poison, usually mixed at the rate of 1 part to 20 parts of sweetened water. Real-

izing that flies are especially fond of sweet milk, my first experiment was to use 1 ounce of formalin in 16 ounces (one pint) of new milk. The first experiment was successful. The formalin-milk mixture was exposed in four plates on the floor of a milk room which was about 15 feet square. The mixture was first exposed about three o'clock one afternoon. Flies commenced to feed and drop dead within a few minutes and continued to die rapidly even while the evening's milk was being brought in and strained. Flies continued to feed and die until dark, and commenced feeding freely again about daylight the next morning. About eight o'clock a. m. the dead flies were swept up and found to measure over one pint, or between five and six thousand in number.

This experiment was repeated for three successive days, exposing a fresh lot of formalin-milk mixture each day about two or three o'clock, and sweeping up the dead flies the following morning. Fully one pint of flies were secured each time, and the number present in the milk room appeared to be considerably reduced. As the milk room was at that time unscreened and flies abundant through the barns and around the manure piles, the poisoning in one small room could not, of course, greatly reduce the numbers, but it proved the value of the mixture as a fly poison.

My next experiment was to determine if a mixture of milk and water, containing formalin, would be as attractive as the whole milk. For this test milk and water were mixed in equal parts and one ounce of formalin added to 16 ounces of the diluted milk. The result was satisfactory. Flies seemed to feed on this as well as on the whole milk mixture.

Formalin was tested in various proportions, using one ounce in ten ounces of whole milk or diluted milk, and at other strengths up to one ounce in twenty ounces of milk or diluted milk. It was found that all proportions were quite effective, but in some cases the strongest mixture seemed to repel the flies, while the weakest did not kill them quickly, and probably a few at least revived, after being partly disabled by the formalin.

Without mentioning details of the various experiments it may be stated that the formalin mixture which gave best average results and which the writer has recommended in newspaper articles, is as follows: "1 ounce (2 tablespoonfuls) of 40 per cent formalin, 16 ounces (one pint) of equal parts milk and water.

"This mixture should be exposed in shallow plates, and by putting a piece of bread in the middle of the plate it furnishes more space for the flies to alight and feed and in that way serves to attract a greater number of them.

"Whole milk can be used, but the diluted milk seems to be just as successful."

Formalin can be purchased at retail price at fifty cents a pint, hence the treatment is not expensive.

POISONING FLIES IN A CALF BARN AND PIG PEN.

A very conclusive test of the efficiency of the above formalin mixture was made in a large calf barn where flies were extremely numerous. Six plates of the mixture prepared like the above formula, were placed

in the passageway between the stalls. This passage is about six feet wide and thirty feet long. The poison mixture was exposed at 12 o'clock, noon, and left until 8 o'clock the next morning. The dead flies when swept up measured three quarts, and certainly one-half as many died in the stalls on each side. I estimated that between forty and fifty thousand flies were killed in twenty hours by this experiment.

Another proof of the value of the formalin-milk mixture was secured by using it in a pig pen. A pen of young pigs located near the calf barn mentioned above was found to contain thousands of flies attracted by the milk used for feeding. As it was not possible to put the formalin mixture in the pen itself, a board was nailed across the top, at a height of about three feet. On this board three medium sized tin plates were fastened to receive the poison mixture. The experiment was started about 4 p. m. and within thirty minutes it is estimated that about 1,000 flies were dead or partly overcome by the formalin. At first the flies did not readily find the plates. It would no doubt have been much better to have confined the little pigs and have placed the plates near the feeding trough. However, this test was successful. The flies continued to feed and die rapidly that afternoon and again the next day, when fresh mixture was exposed. It is interesting to note that after the first half-hour or so the little pigs commenced to eat the dead flies, and after that a fly was hardly allowed to drop before being eaten. The pigs must have consumed a quart or more of flies within a couple of days and showed no symptoms of being injured by them.

CHICKENS CAN SAFELY FEED ON FLIES KILLED BY FORMALIN.

I have fed dead flies, killed by the formalin treatment, to chickens without any injury. Furthermore, I have been advised by a resident of West Raleigh that his chickens consumed the dead flies in great numbers.

This party stated: "We have used the formalin according to your directions, on our back porch and in the back yard, and have killed flies by the thousands. Our chickens eat most of the dead flies and it does not seem to hurt them."

PRACTICAL USE OF FORMALIN AS A FLY POISON.

The experiments recorded above prove that we have demonstrated the efficiency of formalin as a fly poison. It is true that the formalin, if used in the same proportions with sweetened water, will often be very effective, but the milk makes a more attractive bait and in most situations more flies will be killed when it is used instead of sweetened water.

At the writer's suggestion many housekeepers in Raleigh and West Raleigh have used the formalin-milk mixture as recommended above, and several have reported the killing of flies by the pint and quart. A gentleman in charge of a farm where a large horse barn is maintained tells me that he poisoned a gallon of flies the first day he tried the mixture. This statement was vouched for by other witnesses in whom I have perfect confidence.

A good place to expose the formalin mixture is on the front and back porches, where flies are frequently numerous, and waiting to enter when the doors are opened. I know of several people who have used it successfully in this manner.

The use of the formalin-milk mixture in dwelling houses has not proved so successful, except in unscreened kitchens or dining rooms.

This poison was tested in the large college mess hall, where over four hundred students can be seated, resulting in practically cleaning up all the flies in two days. Previous to that time the steward had been using tanglefoot fly-paper, often having as many as thirty sheets exposed. Fully that number were present when the formalin was used; but in spite of them the flies were numerous.

Many entomologists and others who have read the many published articles concerning houseflies probably know that formalin, as a fly poison, has often been condemned, especially, perhaps, during 1910. I am of the opinion that these failures have been due to not using the formalin in an attractive medium, such as milk. It is true that a few people have reported no success with formalin-milk mixture, but I know of several who commenced using it in the wrong proportions, either too strong or too weak, with very little success, but who afterwards mixed it in the proper proportions and at once found that it killed the flies as the recorded experiments amply demonstrate.

OKRA WILT (*FUSARIOSE*), *FUSARIUM VASINFECTUM*, AND CLOVER RHIZOCTONIOSE.

By F. L. Stevens and G. W. Wilson.

The okra wilt prior to this has not been recorded in North Carolina, indeed no record of it at all has come to our notice except the rather vague mention by Smith in 1899[2] and one of its occurrence in Connecticut by Clinton.[3] Dr. Orton writes us that he has records of its collection at Baldwin, Ala., at Dwin, Pa., and at Edisto Island, S. C. The disease is perhaps not of serious importance since the okra can hardly be regarded as a plant of high economic value, though it is a delicacy prized by many and raised quite extensively.

Fig. 15.—Okra leaf affected with wilt.

The present disease partakes of the type of the wilt class of soil diseases. It is due to a fungus which hibernates in the soil and from the soil invades susceptible plants grown there. Soil which has once become infected will in the future cause disease to susceptible plants, the causal fungus remaining for indefinite periods in the soil.

[2]Smith, E. F., U. S. Dept. Agr., Div. Veg. Path. Phys. Bul. 17, Nov. 1899.
[3]Clinton, G. P., Conn. State Sta. Rpt. 1905: 269.

The disease is of especial interest on account of its close kinship to the disastrous wilts of cotton, cowpea, and watermelon, with which it is perhaps identical. The fungus causing these diseases was first described by Atkinson in 1893 as *Fusarium vasinfectum.*[4] It was later made the subject of extensive study by Smith.[5]

Smith concluded that an ascigerous fungus, which he named Neocosmospora and which he found on the diseased plants was the perfect form of the Fusarium which causes the disease. He consequently renamed the fungus Neocosmospora vasinfectum. Later research by B. B. Higgins,[6] of this laboratory, and Butler,[7] of India, strongly indicate that the Neocosmospora is merely a superficial saprophyte and that it has nothing to do with causing the disease. Since the fungus in hand can not be distinguished from *Fusarium vasinfectum* as described by Atkinson[8] on cotton we so designate it here.

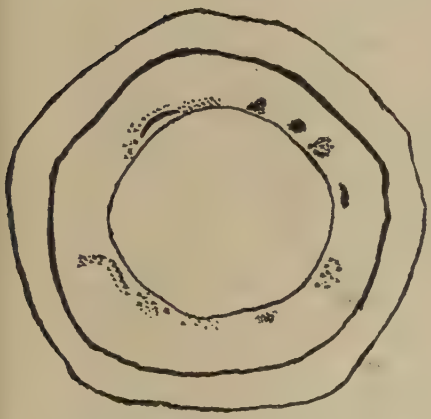

FIG. 16.—Section of upper portion of infected okra stem.

FIG. 17.—Section near base of infected okra stem.

DISEASE ON OKRA.

In general the disease agrees closely with the wilt of cotton as described by Atkinson.[9] The first symptom is the wilting of a portion of a leaf, usually the part most distant from a main vein. This wilting is accompanied by loss of green color, a gradual change to yellow or white, followed by death of the tissue, and browning. If the dead portions be near the margin the leaf may roll or curl. Fig. 15. Cross section of the petiole of such leaf reveals blackened strands running lengthwise through the woody parts. If these strands are located

[4]Atkinson, G. F., Alabama Sta. Bul. 41: 19-21.
[5]Smith, E. F., U. S. Dept. Agr., Div. Veg. Path. and Phys., Bul. 17.
[6]Higgins, B. B., Science, N. S. 31: 916. 1910; and Ann. Rep. N. C. Sta. 1909: 100-116. 1911.
[7]Butler, E. J., Mem. Dept. Agr. India, Botanical Ser., Vol. 2, No. 9. 1910.
[8]Loc. Cit.
[9]Atkinson, G. F., U. S. Dept. Agr., Office Expt. Sta. Bul. 33: 287. 1893.

mainly on one side of the petiole the corresponding side of the leaf first exhibits symptoms of disease. Sections made in the stem below the point of attachment of a diseased leaf show these dark strands running down the stem, and as the base of the plant is approached the dark strands increase largely in number. Figs. 16 and 17. In the roots a similar condition is met. Some roots bear so many dark strands that the whole of the wood is almost black. Other roots may be normal and uninfected.

FUNGUS IN THE HOST.

The gross character, indicating the presence of the fungus in the host is the blackening of the walls of the vascular bundles in the infected area. Closer examination shows these diseased bundles to contain more or less abundant whitish or brownish mycelial threads. These increase

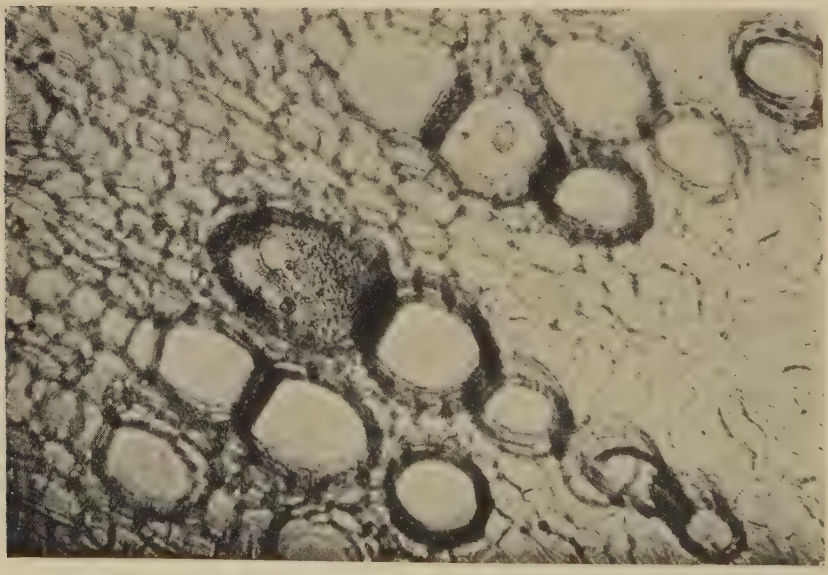

FIG. 18.—Photomicrograph showing vascular bundles of diseased okra stem.

in abundance with the progress of the disease until at last the tubes are filled completely with the interwoven hyphæ, causing a cessation of the sap flow and consequent wilting of the host.

ISOLATION OF THE FUNGUS.

Sections from diseased stalks were placed in a moist chamber and in a few days were covered with a growth of hyphæ bearing conidia of the Fusarium type. Shreds of diseased tissue were also placed in petri dishes with agar and developed the same fungus, which was kept under observation in pure culture for some months.

FUNGUS IN CULTURE.

The fungus grew freely in cultures of pea-agar and was constant in its characters, which agree well with those of *Fusarium vasinfectum*. Conidia were produced in abundance. Perhaps the most interesting feature developed in the cultures was the uniform presence of numerous black sclerotia-like bodies similar in structure to those described by Appel and Wollenweber,[10] for *F. Solani* and related species. These appear to be of the nature of sporodochia, as they are associated with conidia production.

CLOVER RHIZOCTONIOSE.

During the past season several complaints came to the Station of a crown disease of clover which was devastating entire fields. These reports came especially from Buncombe and Stokes counties. Rhizoctonia was abundant on the roots and was clearly the cause of the trouble.

About the same time an epidemic of "damping off" appeared in the horticultural greenhouse. Examination showed Rhizoctonia on seedlings of cabbage and scuppernong grapes and on cuttings of aucuba, berbeis, privet, loquat, laurel cherry, pomegranate, hibiscus, begonia, and cratægus.

[10]Appel, O., and W. H. Wollenweber, Arbeit. K. Biolog. Anstalt. f. Land. u. Forstwertschaft. Vol. 8, part 1, plate 1, Fig. 23, 59, etc. 1910.

NORTH CAROLINA
AGRICULTURAL EXPERIMENT STATION
WEST RALEIGH

C. B. Williams, *Director.*

PRESS BULLETIN No. 22
January 25, 1911

USE OF LIME ON THE FARM

Because of a misconception as to the action of lime there is much misuse of lime by a goodly number of farmers. In many cases where marked results have followed the use of this material the conclusion has been drawn that it is the only one that needs to be added to the soil in order to secure large yields annually thereafter. Such a conclusion is not justified by the facts in the case, and if this material is used and depended upon entirely it will be found in time that the beneficial results will gradually grow less. There is no truer saying than that the indiscriminate use of the lime enriches the father but beggars the son if it is depended upon solely for average soils. It should be remembered that, although lime is as essential for plant growth as phosphoric acid, nitrogen and potash, it is not able to replace any one of these nutrients in the promotion of plant development.

UNDER WHAT CONDITIONS USE.

As a direct plant food for such crops as corn, cotton and the small grains planted on most of our soils, it is seldom needed, but for leguminous crops, such as the clovers, vetch, peas and alfalfa, its use is usually imperative for the best returns with those soils not well supplied with lime. It might be stated in this connection that as a general rule with most of the upland and coastal soils of the State it is generally necessary to use an application of lime to secure the best results with the growth of leguminous crops. Usually the most marked results with general farm crops have followed the use of lime on soils which have been allowed to get into a bad physical condition or to become sour or acid, either through a large accumulation of organic matter, poor drainage or insufficient aeration brought on by poor preparation and cultivation, or all combined. The writer has seen applications of lime to soils which have been allowed to get into a sour condition change the yields of corn in one year from a complete failure the previous year to splendid yields the year following the application of lime. In cases like this—and there are many such soils in the State—the chemical and physical conditions

of the soil were such that, although the soil had abundant plant food for large yields for many years, yet ordinary crops like corn would not grow to any extent until these conditions were made suitable for their growth. When lime was added it neutralized or destroyed the acidity of the soil, and at the same time improved its physical and chemical condition and biological character to such an extent that afterwards for years the yields were good. Here the beneficial results are largely due to the favorable action of the lime on the soil rather than in supplying lime as plant food to the crop. In addition to supplying plant food and improving the chemical, biological and physical condition of the soil, lime hastens the decomposition of organic matter in the soil, liberating much of the inert or locked-up nitrogen contained in the organic matter or humus. Also the store of inert potash and phosphoric acid of the soil is acted upon by the lime, and a decidedly larger percentage is brought into an immediately available form annually for plant growth than would have been through ordinary agencies operating in the soils. Hence lime tends to hasten the exhaustion of these constituents of the soil rather than build the soil up, especially when the lime is used alone, continuously, without fertilizer, on poor soil.

HOW DETERMINE WHEN LIME IS NEEDED.

If the land contains a large amount of organic matter (usually indicated by dark color of the soil) it is fairly safe to assume that such soils, if crops do not yield well on them and they have not received an application of lime or marl in recent years, that they would be benefited by liming or marling.

If sheep sorrel, button weed and the water grasses are growing in the fields it will usually be found that such soils will respond favorably to applications of lime. If blackberries, cranberries, raspberries or gallberries are growing wild on the same type of soil in close proximity to the field in question, it will generally be found that an application of lime will prove beneficial for ordinary crops like corn and the small grains on such a field.

If it is an old field that has been robbed of its humus by continuous cultivation in some clean cultured crop, like cotton, and the soil of which runs together and cements after each rain, it is quite likely to respond profitably to an application of lime, especially for the growth of such crops as clover, vetch, peas and other legumes. If a heavy growth of some green crop is turned under, especially in the spring, an application of lime or marl should be made before turning in order to prevent the formation and accumulation of a large amount of organic acids in the soil by the rotting of the crop turned under. If the soil has been poorly drained, and has become tight and water-sogged, lime will in most cases prove highly beneficial when applied soon after drainage and before a crop has been put in. If clover, vetch, cowpeas and peanuts are to be grown upon ordinary upland soils, it will usually pay to make a good application of lime to the soil, the best results usually following with cowpeas, if the application is made to the crop growing previously on the land; while with peanuts the opposite is frequently true.

If a soil is quite acid its presence may be determined by means of litmus paper. Take a portion of the soil to be tested into the hand and make it into the consistency of a mud pie by adding water and working with the hands. Now take a small strip of blue litmus paper, which may be secured from any local drug store, and bury it in the mud pie. After remaining for a minute or two remove the litmus paper and wash in clear water, and if the soil is acid or sour the color of the paper will have been changed from the original blue to a red color. Of the commonly grown farm crops probably oats and Irish potatoes are the most tolerant of large amounts of acidity in the soil.

WHEN APPLY.

Although conditions and systems of rotation will modify to some extent the time of application, yet, usually, the safest time to apply this material to the soil will be during the fall or early winter, especially so if either the caustic or slaked form is used. If carbonate of lime be employed it may go on in the spring with less danger of injury to the seed of the crop than when either of the two forms mentioned above is used. When the application is made in the fall, time is afforded for the lime to become well mixed with the soil before spring, especially so if it is put in properly. The carbonate or air-slaked form of lime does not act as energetically as do the quick and water-slaked forms.

HOW APPLY AND AMOUNT.

As a general rule lime should be applied broadcast and then thoroughly harrowed and disked into the soil. Of slaked lime the quantity required per acre varies quite considerably with different soils, crops and conditions. Usually, however, the amount necessary to use will vary between 1,000 and 3,000 pounds, or its equivalent of some other form, per acre. Never mix lime, especially in the caustic or water-slaked forms, with any material containing ammonia, before applying it to the soil, because the lime would tend to set free into the atmosphere some of the ammonia, and hence it would be lost. For this reason it is exceedingly unwise to mix lime directly with stable manure. Do not add lime to acid phosphate or to mixtures containing this material, for such a procedure would result in some or all of the available phosphoric acid of the acid phosphate being changed to a less soluble or available form, the amount changed being governed largely by the proportion of lime to acid phosphate in the mixture and by the mechanical condition of the mixture.

When lime is added to permanent pastures and meadows it should be applied broadcast in the fall or early winter and left on the surface. For this purpose the carbonate form will usually be found best suited.

FORMS OF LIME AND THEIR EQUIVALENTS.

There are three chemical forms of lime used commercially other than gypsum (land plaster) or sulphate of lime. Each of these forms are

known by a goodly number of names. The forms and synonymous names are as follows:

(1) Caustic, quick, burnt, builders, rock, stone or unslaked lime.
(2) Carbonate, agricultural, marble, limestone, marl or air-slaked.
(3) Water-slaked or hydrated lime.

As all three of these forms of lime are suited for agricultural purposes it becomes important in purchasing to know the relative equivalents in actual lime (calcium oxide). When 178 pounds of a good grade of carbonate of lime is burnt in the kiln about 100 pounds of quick or caustic lime is secured, the remaining 78 pounds of the original substance is driven off into the atmosphere as carbon dioxide or carbonic acid gas. If the above 100 pounds of quick lime, secured by burning, is exposed to the atmosphere for some time, it will absorb carbon dioxide again from the air, and will, when fully saturated with it, weigh 178 pounds. If 56 pounds of the burnt or quick lime is water-slaked with just enough water to complete the chemical change, the resulting hydrated or water-slaked lime will weigh about 74 pounds. In other words, 100 pounds of quick lime will take up in chemical combination about 32 pounds of water, thereby increasing its weight about one-third by water-slaking.

From the above it may be seen that the most concentrated form of lime is the caustic or burnt lime. This being so, where the lime has to be freighted long distances on the railroad or hauled several miles on country roads, or both, it will usually be found that this will be a cheaper form in which to buy lime, but not always. For instance, the freight on a carload of carbonate of lime (agricultural lime so called) will be the same as that on the same amount of quick or burnt lime, yet there would be almost twice as much actual lime (calcium oxide) in the latter as in the former, hence the freight on the lime contained in the quick form would be only about one-half of what the actual lime contained in the carbonate form costs per ton.

In securing quotations on lime do so upon percentage composition of calcium oxide and upon delivery at your nearest railroad station. If they are secured in this way it will not be difficult to decide from whom to purchase. If these precautions are not observed it will not always be easy to decide which will be the cheapest source from which to secure one's supply of lime. One bushel of good stone or rock lime will weigh about 90 pounds, and when slaked will produce about three bushels of slaked lime, which will weigh approximately 45 pounds per bushel.

Pure burnt oyster-shell lime weighs about 60 pounds to the bushel. When it is slaked about two and one-half bushels of slaked lime is formed, which will weigh about 40 pounds per bushel.

C. B. Williams, *Director.*

NORTH CAROLINA
Agricultural Experiment Station
WEST RALEIGH

C. B. WILLIAMS, Director

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How to Suppress Houseflies

That the housefly nuisance in any community can be largely suppressed by united effort on the part of those who are interested can not be denied by any one who understands the situation.

The fly is not only disagreeable but is a menace to health. Typhoid fever and cholera infantum, and probably other intestinal diseases are often carried to victims by flies.

Steps should be taken in every community to commence a vigorous fight against this pest and it seems advisable to let every one become well informed about the breeding places of flies, and the methods of preventing them. Poisoning and trapping the flies is also of great importance.

LIFE HISTORY AND BREEDING PLACES OF HOUSEFLIES.

Flies originate largely from the horse, cow and mule stables. Cow manure will breed flies in great numbers, in spite of many reports to the contrary. In and around such places the flies lay their eggs. Fully ninety-five per cent of all the flies develop in the stable manure. Garbage piles, heaps of decaying vegetable matter, and any accumulation of filth may breed flies.

The eggs hatch in less than twenty-four hours into small, white, wriggling maggots.

The maggot stage of the flies lasts only five days in warm weather. Full grown maggots are about one-third inch long, with body pointed at the head end.

The full grown maggot changes to a reddish-brown pupa stage, about one-fifth inch long, which lives about five days, and then transforms to the adult winged fly.

A generation of houseflies, from egg to adult stage, may develop in ten or eleven days. *This shows that if the stable manure is hauled out once a week, flies will not have time to mature.*

Fully fifteen generations of houseflies mature during the summer.

Each female fly will lay about one hundred and twenty eggs, and this fact serves to account for the great numbers of flies where the breeding places are not done away with in a community.

Flies do not usually travel over a few hundred yards from their breeding places, so that it is entirely practicable, by united effort on the part of those who are interested, to do away with most of the houseflies in any community.

POISONING FLIES WITH FORMALIN.

There are several more or less successful fly poisons, such as Seibert's Poison Fly Paper, but the writer has had best success with *Formalin.* This costs only fifty cents a pint, and is used by placing *one tablespoonful in a half pint cup* of one-half each of milk and water. This should be exposed in plates, and it is well to put a piece of bread in the middle of the mixture to furnish more surface on which the flies can light and feed.

This formalin solution seems to attract the flies and kills them quickly. The writer recently poisoned over forty thousand (about 4 quarts of flies) in less than twenty-four hours in a calf barn where the flies were very numerous. In this manner thousands of flies are killed before they have deposited eggs.

When attempting to poison flies around dwelling houses it is best to expose the formalin poison mixture outside as well as inside the houses. Use it on the front and back porches where the flies are waiting to enter whenever the doors are opened.

We can never succeed in permanently lessening the fly nuisance by simply poisoning or trapping the flies, but when we attempt to prevent the breeding places, the work of poisoning the adult flies will be of great assistance.

Every citizen who is interested in the health and welfare of his family should determine where the flies are breeding and should not be suspicious of his neighbor's premises until he has made a careful search for the breeding places of flies on his own place.

R. I. Smith, *Entomologist.*